Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

APRIL, 1949

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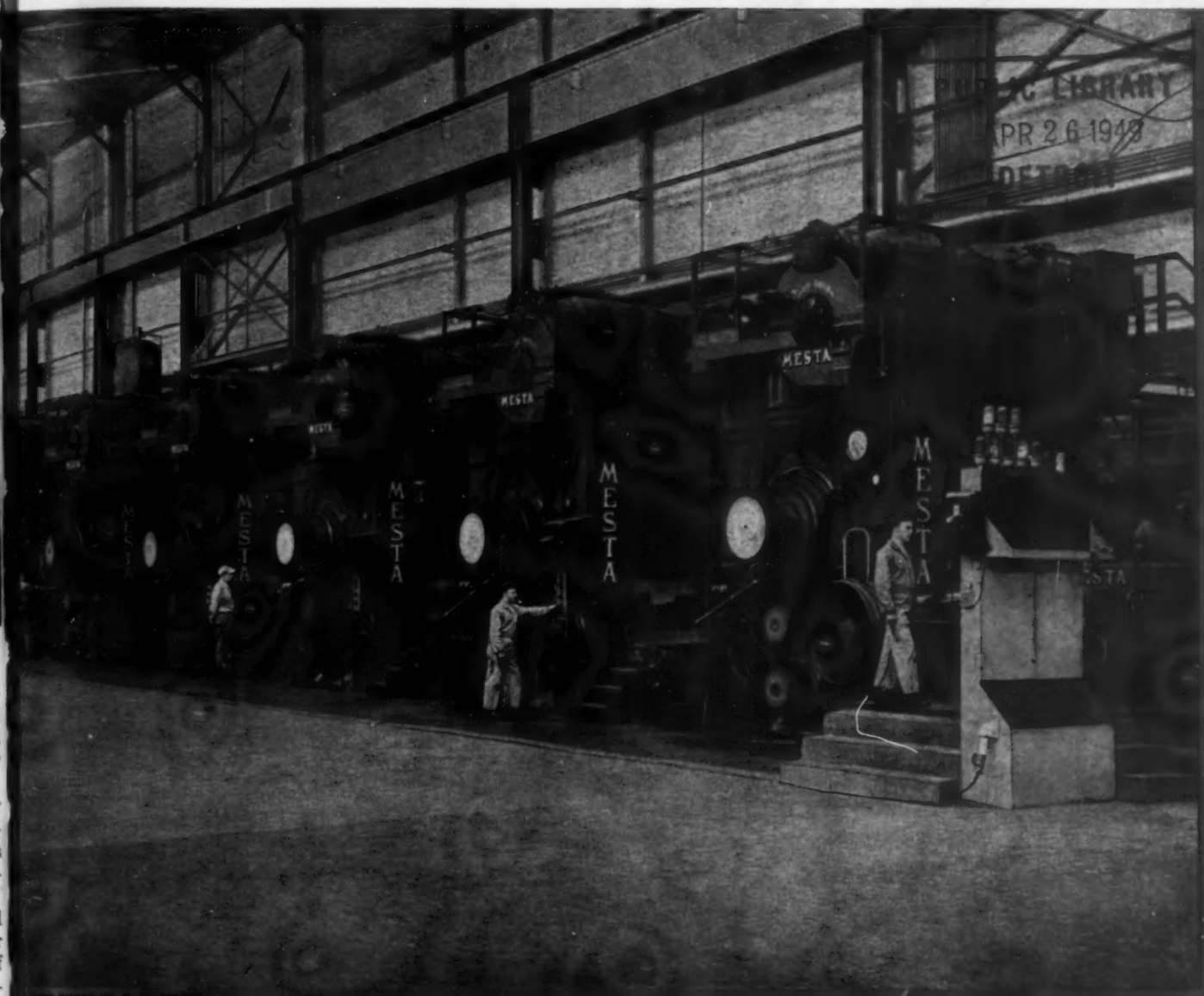


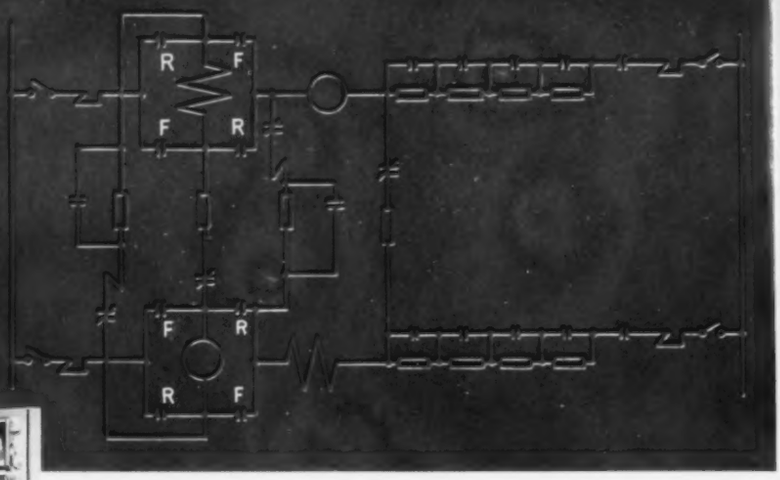
Mesta 68" Four-High Continuous Hot Strip Mill Finishing Stands

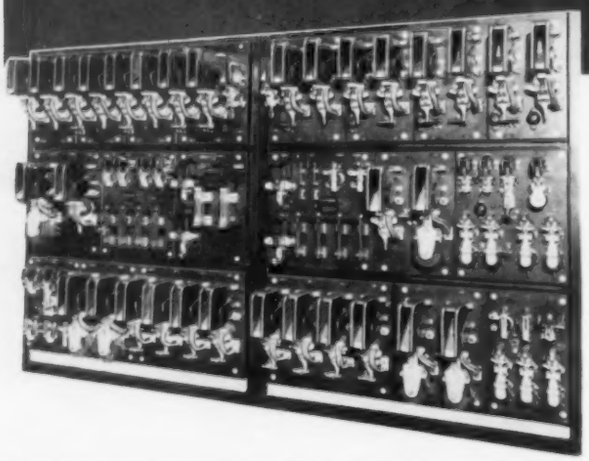
HOT STRIP MILLS
. . . designed and built by
MESTA

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS
MESTA MACHINE COMPANY • PITTSBURGH, PA.

What control for what mill equipment? One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.

When you have a two or four motor bridge drive on a crane or ore bridge . .





. . That calls for

Cutler-Hammer No. 14145 (Wilson-Ritchie) D. C. reversing Dynamic Braking Control

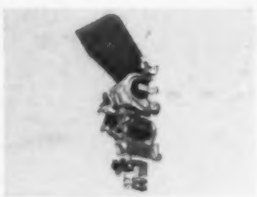
In addition to the unique Cutler-Hammer *Ltl* Inductive Time Limit method of acceleration, Cutler-Hammer Bulletin No. 14145 also employs the Wilson - Ritchie scheme in case of power failure for emergency dynamic braking on series wound motors.

This safety feature is gained by cross-connecting series fields and motor armatures to provide the correct polarity for dynamic braking by self-excitation. The feature may be used both for emergency stops and service stops. The contactors used are C-H standard, affording the ruggedness and simplicity that make Cutler-Hammer Mill Control outstanding.

NOTE: As shown at left, Cutler-Hammer also makes available emergency dynamic braking for single motor applications as well. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. Associate: Canadian Cutler-Hammer, Ltd., Toronto.

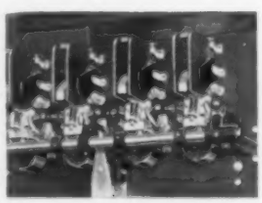
CUTLER-HAMMER
MOTOR CONTROL
C-H

Typical Components of Cutler-Hammer Mill Control



Mill-type contactors whose reliability, life and low maintenance have made them the standard for industry.

Space Heaters provide easily installed, comfortable heat for operators in crane cabs, etc.



Emergency dynamic braking panel for single motor crane installations.

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TECHNOLOGY DEPARTMENT

Amazing Secret Process—

Carnegie-Illinois Using New Galvanizing Method

By HI HOWARD

Carnegie-Illinois Steel Corp. today took the wraps off an amazing new industrial process at its huge Irvin Works here—a production line for continuously galvanizing a wide ribbon of steel.

Advantages claimed are both greatly increased output and higher quality.

Galvanizing is the process of coating steel with zinc to protect it against rust and corrosion.

As this work is done in all other steel plants now, the steel is first cut into flat squares or rectangles which are fed through a bath of molten zinc.

In the new Carnegie-Illinois process, the strip of steel flows continuously through the molten zinc bath, and can be sold either cut up into sheets or in coil form.

NEW FURNACE—

The secret of the new process is a new-type furnace with a controlled atmosphere, mostly a mixture of hydrogen and nitrogen with as much air excluded as possible.

As the strip steel enters this 117-foot long furnace, electricity heats it red hot and then the hydrogen and nitrogen gases gradually cool it to just above the temperature of the molten zinc.

This "continuous" furnace, officials explain, replaces conventional box furnace annealing—a method which now requires from 10 to 12 days to soften coils of sheet steel. In addition, the controlled atmosphere of the furnace eliminates the necessity of another batch "pickling" process to clean the steel.

HEAVY SHEETS—

The galvanizing line now operating at Irvin Works produces heavy sheets, about one-tenth of an inch thick. Another similar line is under construction—with completion expected in early spring—to produce galvanized strips and sheets in the lighter, thinner gauges.

Output of the heavy material is now at the rate of about 300 tons per day, equal to about 100,000 tons annually. Completion of the second line will make it possible to double this production.

There is an excellent demand now for galvanized strip and sheet. The heavier sheets go principally into railroad car roofing, culvert pipe, storage tanks, heavy drums, and railroad refrigerators. The lighter sheets and strip are used for roofing, siding, gutters, builders' specialties, and other products.

GIVES EDGE—

Carnegie-Illinois development of a continuous galvanizing process appears to give this U. S. Steel subsidiary an edge over its competitors in the marketing of a product which is usually sold in a highly competitive market.

The company constructed its new line behind barricades and went to elaborate precautions to maintain secrecy. But patent applications are now being made.

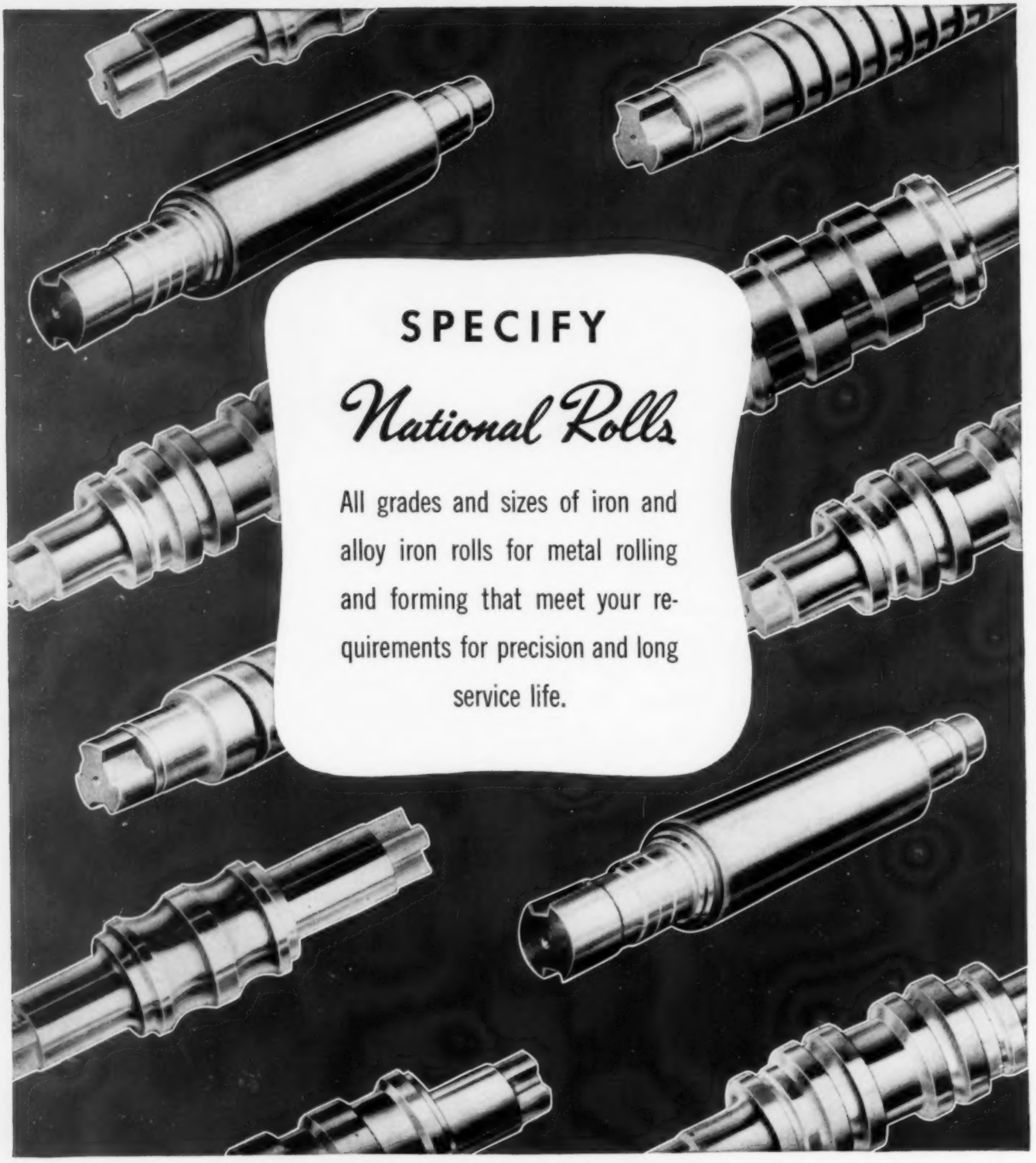
No announcement has been made of the investment involved in the new process. But it was obvious that the buildings, machinery, and equipment involved represents a very large sum—estimated at several millions. The new line itself is nearly 500 feet long.

Over and above the increase in output, improved quality is the greatest advantage, according to J. E. Lose, vice president in charge of operations, Carnegie-Illinois Steel.

Reprint from The Pittsburgh Sun-Telegraph

● Another milestone . . .
Bold planning, continuous research and progressive thinking, symbols of the mighty steel industry, make possible advances like continuous wide strip galvanizing. Working side by side to achieve the results, are the specialists of the industry and the equipment manufacturers like The Aetna-Standard Engineering Company.

THE AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN, OHIO
ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
AETNA-STANDARD ENGINEERING COMPANY, LTD., TORONTO, ONTARIO, CANADA


SPECIFY
National Rolls
All grades and sizes of iron and alloy iron rolls for metal rolling and forming that meet your requirements for precision and long service life.

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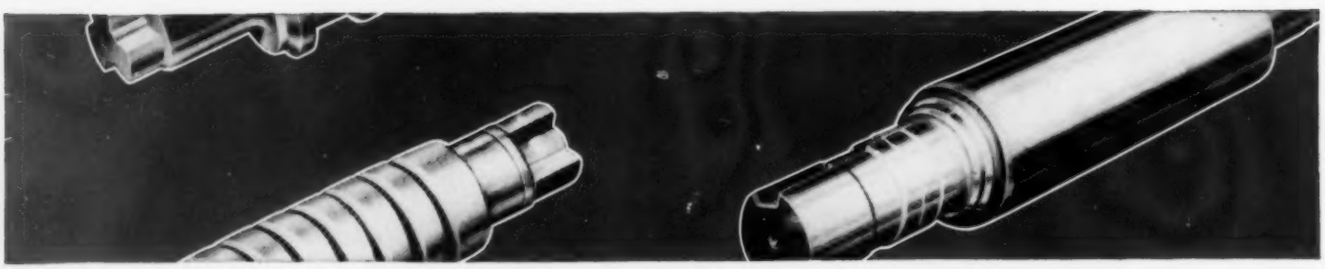
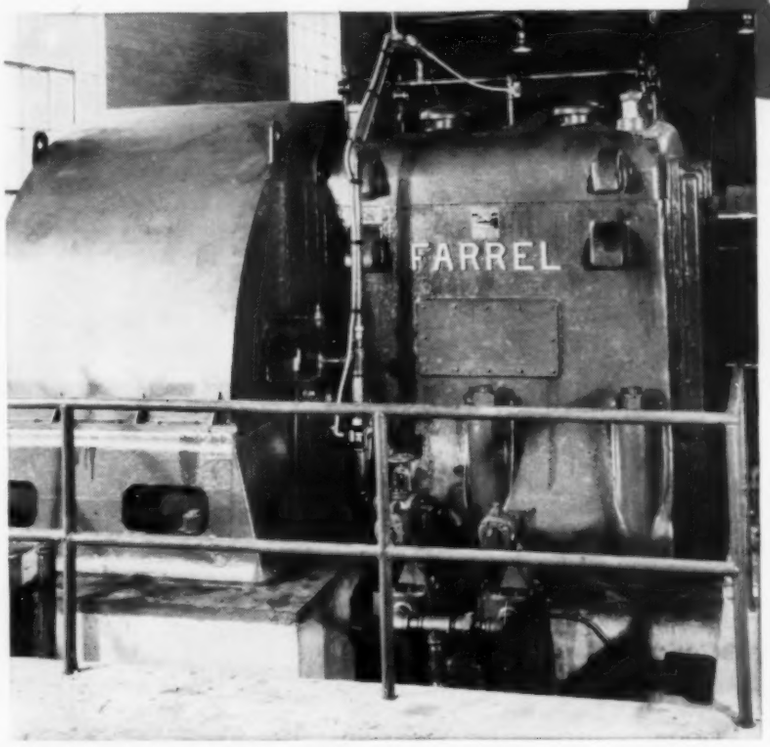
AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON AND ALLOY IRON ROLLS



GEARS LAST LONGER... Run More Smoothly



Courtesy Farrel-Birmingham Company, Inc.

...when you give them the extra protection of Texaco Meropa Lubricants

GIVE your enclosed reduction gears and their bearings in heavy-duty service the heavy-duty protection of *Texaco Meropa Lubricants.* You'll get smoother operation, longer gear life, and lower maintenance costs.

Texaco Meropa Lubricants easily carry the heaviest loads, and cling persistently to the gear teeth, giving full protection always. *Texaco Meropa Lubricants* are long lasting . . . resist oxidation and thickening . . . do not foam . . . do not separate in service, storage or centrifuging. They protect against bearing corrosion.

In circulating systems for oil film roll necks, use *Texaco Regal Oils.* These heavy-duty, turbine-grade oils strongly resist oxidation, emulsification and sludging . . . keep the system clean for full protection and lower maintenance costs.

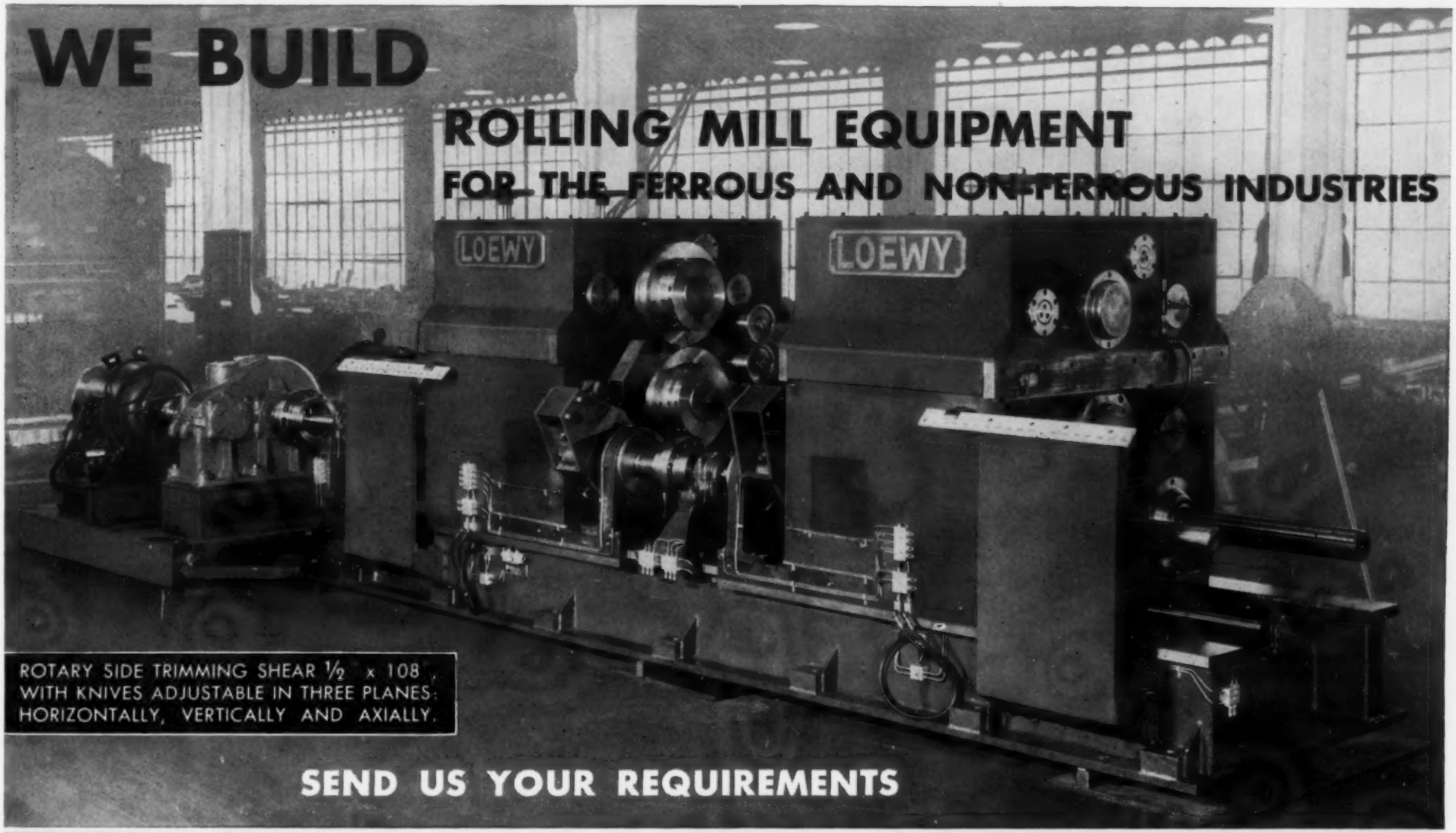
Let a Texaco Lubrication Engineer help you get greater efficiency and economy through effective lubrication. Just call the nearest of the more than 2300 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Meropa Lubricants

FOR STEEL MILL GEAR DRIVES

Tune in . . . TEXACO STAR THEATRE presents MILTON BERLE every Wednesday night. See newspaper for time and station.


WE BUILD
ROLLING MILL EQUIPMENT
FOR THE FERROUS AND NON-FERROUS INDUSTRIES
LOEWY
LOEWY
ROTARY SIDE TRIMMING SHEAR ½ x 108", WITH KNIVES ADJUSTABLE IN THREE PLANES: HORIZONTALLY, VERTICALLY AND AXIALLY.
SEND US YOUR REQUIREMENTS

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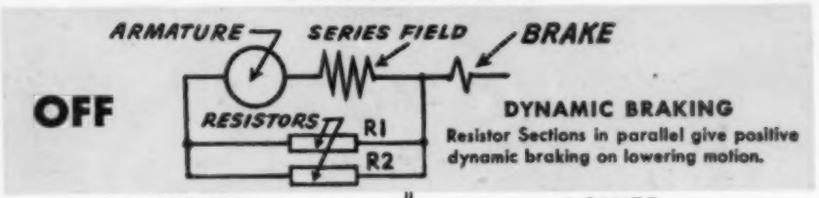
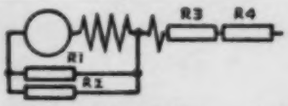
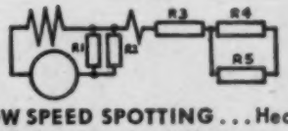
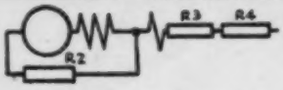
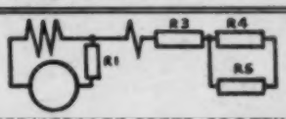
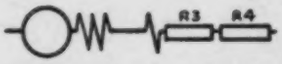
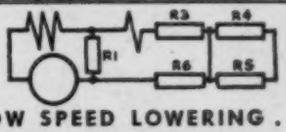
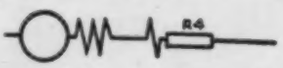
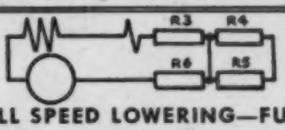
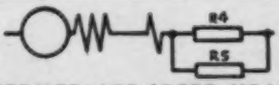
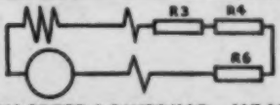
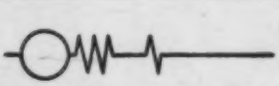
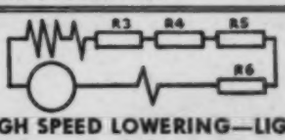
CHICAGO DETROIT SAN FRANCISCO SEATTLE
WASHINGTON, D. C.

New DYNAMIC LOWERING NETWORK SYSTEM FOR HOIST CONTROL

OPERATION



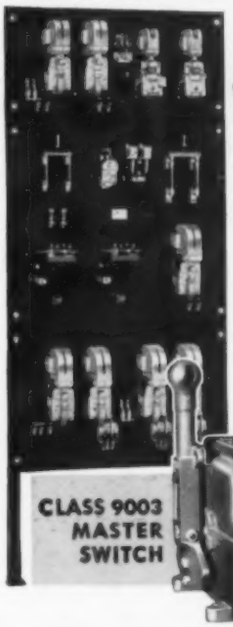
HOIST	LOWER
1 H  SLACK CABLE POINT . . . Double Armature Shunt	1 L  LOW SPEED SPOTTING . . . Heavy Field, Regenerative Action
2 H  LOW SPEED-LIGHT HOOK . . . Single Armature Shunt	2 L  INTERMEDIATE SPEED SPOTTING . . . Increased Armature Resistance
3 H  INTERMEDIATE SPEED-LIGHT LOAD . . . Series Resistor	3 L  LOW SPEED LOWERING . . . Network, Bridge Connection
4 H  LOW SPEED-HEAVY LOAD . . . Series Resistor	4 L  FULL SPEED LOWERING—FULL LOAD . . . Network, Potentiometer Connection
5 H  INTERMEDIATE SPEED-HEAVY LOAD . . . Series Resistor, Parallel Connection	5 L  HIGH SPEED LOWERING—HEAVY LOAD . . . Full Field
6 H  FULL SPEED . . . Across-the-line	6 L  HIGH SPEED LOWERING—LIGHT LOAD . . . Field Weakening

Safer. Two spring closed contactors and resistor sections in parallel insure positive dynamic braking on lowering motion.

More Control over hook. Double armature shunt makes slack cable and low speed—light hook points individually adjustable. Series relay provides for high speed lowering of heavy load with full field stability, and yet permits field weakening necessary for high speed lowering of light loads.

Reduced Maintenance. Network circuit is designed for low current peaks during motor acceleration. Maintenance is minimized on control contactors as well as on motor commutator and brushes. Only nine contactors are required for control system.

Less Space for resistors. Network system is designed for maximum use of resistor sections, and reserve capacity can be provided within reasonable dimensions.



Class 7954 Dynamic Lowering Hoist Control Panel

Only nine contactors are needed to give better hook control with the new network system.

Write for descriptive Bulletin 7954. Square D Company, 4041 N. Richards Street, Milwaukee 12, Wis.

SQUARE D COMPANY

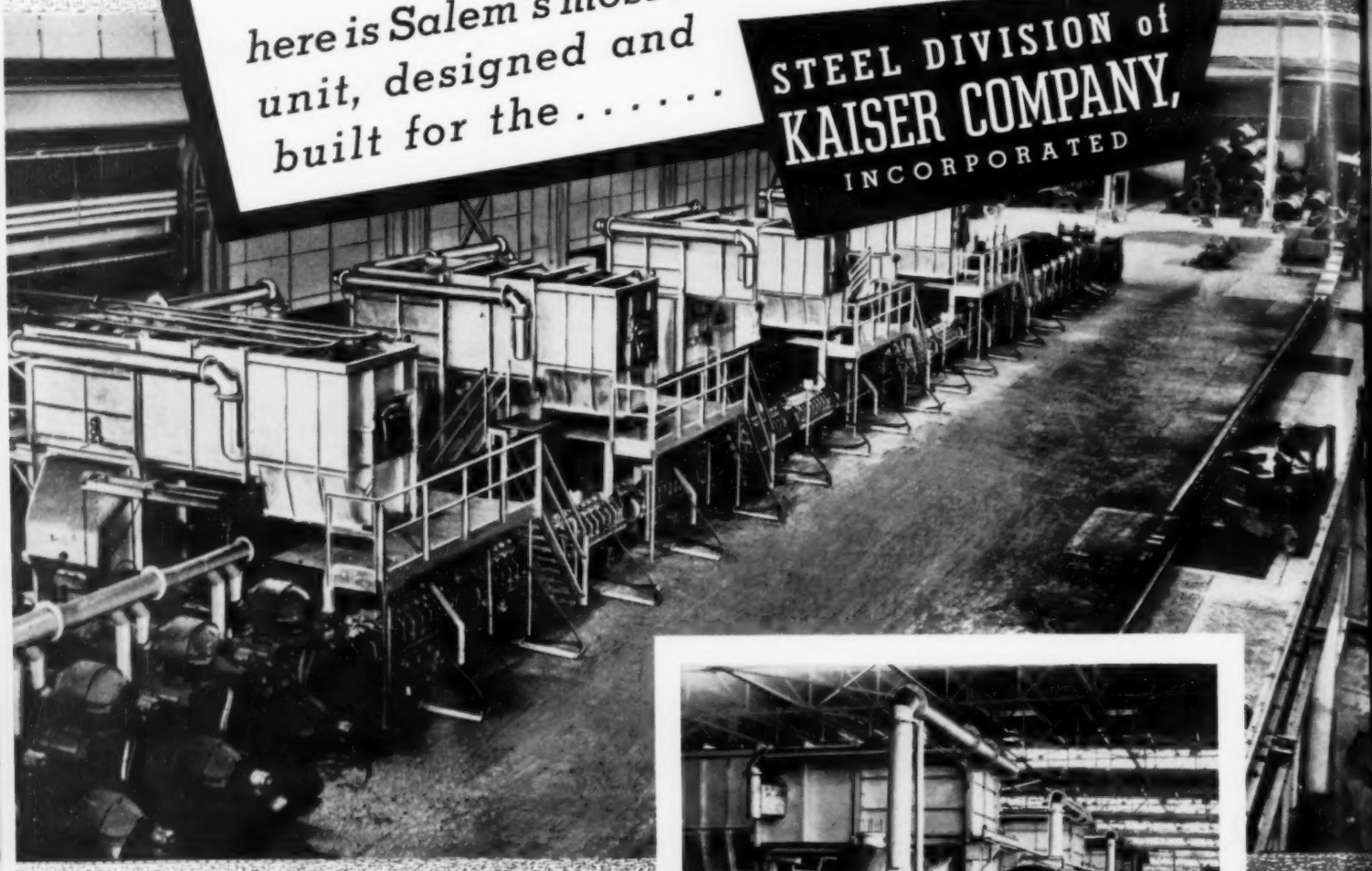
DETROIT • MILWAUKEE • LOS ANGELES

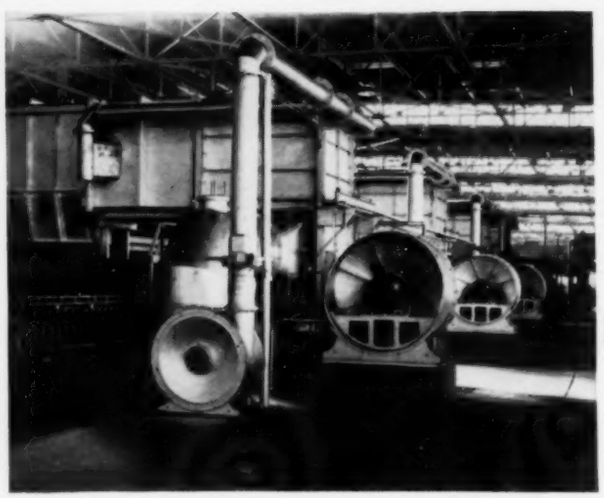
SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

Speaking of CONTINUOUS-WELD PIPE PRODUCTION...

here is Salem's most recent skelp-heating unit, designed and built for the .....

STEEL DIVISION of KAISER COMPANY, INCORPORATED





ABOVE: General view of the long, four-zone, skelp-heating furnace as seen from the discharge end looking toward the charge end.

RIGHT: Recuperator side of the same furnace, showing one metallic recuperator chamber for each of the four independently-controlled firing zones.

● This furnace in the Fontana, California plant of the Kaiser Company, Inc. is capable of heating forty to forty-five tons of skelp per hour for heavy pipe. The heating unit is designed for heavy oil or gas firing. ● Needle type metallic recuperation utilized on this installation provides air pre-heat temperatures up to 1000° F. This type of recuperator offers air-tight construction and high heat-transfer coefficients, assuring effective combustion control and excellent fuel efficiency.

Salem Engineering Company

HEADQUARTERS FOR HEAT TREATING DESIGN

BW-2

Salem, Ohio *Southwest Office, Fort Worth, Texas*

Salem Engineering (Canada) Ltd., Toronto, Ont. • Salem Engineering Company, Ltd., Milford, Nr. Derby, England

BIG

CRANES

Speaking of BIG cranes, here's the giant of them all—the largest crane in the world! Designed and built by Alliance—World's Largest Builder of the World's Largest Cranes—this rugged giant spans the Navy's mole at Hunter's Point, California . . . is so big and powerful that it easily lifts a 500-ton battleship gun turret. It has its own electric sub-station, aerial beacons to warn aircraft away, and a short-wave radio for communication between the operating crews. The bridge span of the crane is 142 feet, and the span of the trolley is 20 feet.

This is but one of the thousands of big cranes developed and built by Alliance. Of course, there are smaller ones, too—all sizes, in fact, to handle heavy loads of all types. For economical, dependable lifting power in your plant, let Alliance develop the equipment best suited to your company's material handling operations.

THE ALLIANCE MACHINE COMPANY

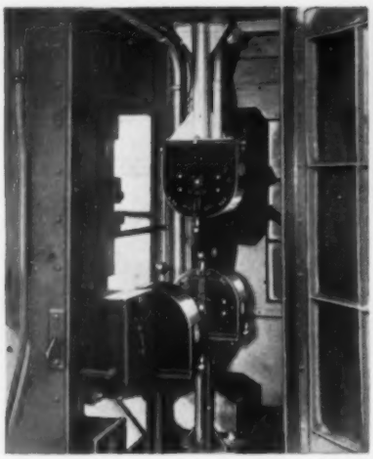
MAIN OFFICE
ALLIANCE, OHIO

PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES
STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH
CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

Alliance

FIRST IN SIZE . . .
FIRST IN CRANE DESIGN



ON THE ORE BRIDGE

● Interior view of the operator's cab, showing EC&M Cam-type Master Switches.

● Close-up of the ore bridge trolley, showing one of four EC&M No. 60 Type WB Brakes.

FOR SLAG RECLAMATION

● No. 5 Type SW-SK All-welded Lifting Magnet handling 10-ton rectangular ingot for breaking up slag.

EC&M Magnets and Motor Control

Help Boost Steel Mill Production

EC&M Equipment has a reputation for efficient operation over a long period with minimum inspection and maintenance. The fundamental features built into every piece of EC&M apparatus contribute to this end result: All-welded magnet construction; long-life, easily adjustable brakes; short-throw master switches; acceleration by TIME-CURRENT relays; contactors of LINE-ARC design; simplified, safe, dynamic lowering (The Wright Circuit) for crane-hoists, etc. For top results, put your magnet and control problems up to EC&M.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79th STREET • CLEVELAND 4, OHIO

● *IN THE COLD STRIP MILL*

EC&M Type CSM Magnet handling 41,000-lb. coil of strip steel.

● *FOR SOAKING PIT COVER CRANES*

EC&M Controllers and Cam Master Switches are shown at the left in the view below. WB Brakes and Manual-Magnetic Disconnect Switch are mounted on the top of the crane.

● *AT THE COKE PLANT*

Two No. 4 Type SW Separator Magnets remove tramp iron from coal conveyor belts.

"Standards" for Rolling Mill Practice

LEWIS

ROLLING MILL EQUIPMENT

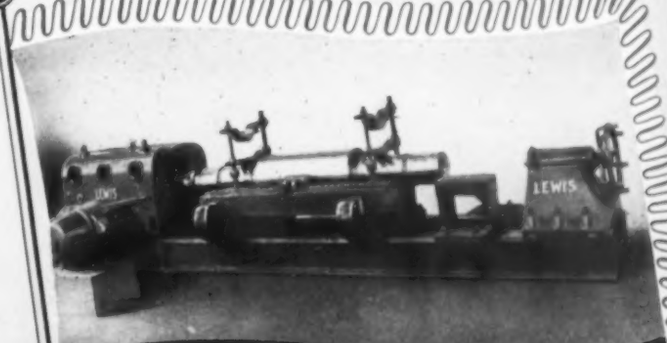
LEWIS FOUNDRY & MACHINE
Division of Blaw-Knox Co., Pittsburgh, Pa.

Designers and Builders of Rolls and Rolling Mill Equipment

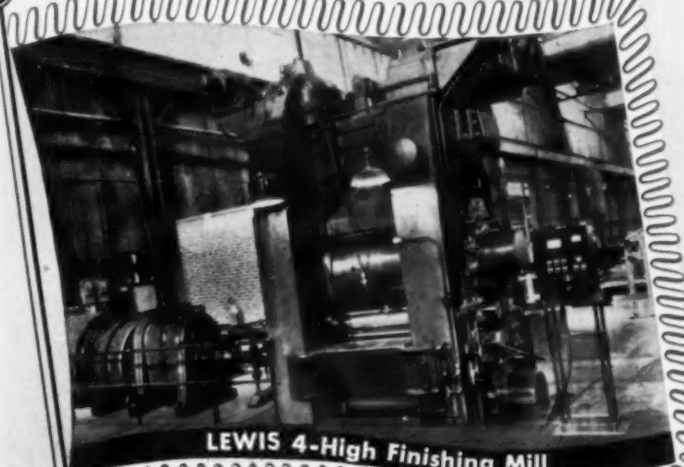
LEWIS 4-High Foil Mill

LEWIS 26½" and 42" x 112" 3-High Balanced Finishing Plate Mill and Tables

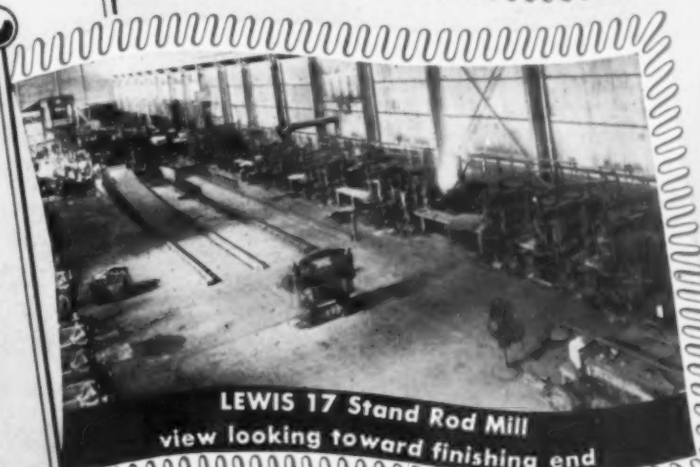
BEDS — Cooling
BLANKS — Gear • Pinion
BOXES — Coupling
CASTINGS — Rolling Mill Furnace
COILERS — Ferrous and Non-ferrous Strip
GEAR DRIVES
GEARS AND PINIONS — Bevel • Double Helical • Single Helical • Speed Reduction • Spur
HOUSING PINION — Rolling Mill
LATHES — Roll Turning
LEVELERS — Roller for Plate and Sheet
MACHINERY — Special • Flaking Mill • Rolling Mill
MACHINES — Pickling
MANIPULATORS — Rolling Mill
MILLS — Aluminum Foil • Bar • Billet and Blooming • Brass and Copper • Cold Rolling • Continuous • Edging • Four-High • Single Stand • Reversing and Tandem • Merchant • Plate Rolling • Precision • Sheet and Strip • Slabbing • Three-High • Tin Plate • Universal • Wire • Zinc Strip • Roughing and Finishing
REELS — Tension
ROLL RAGGING ATTACHMENTS
ROLL POLISHERS
ROLLS — Alloy Iron • Chilled Iron • Sand and Chilled Iron • Steel
SAWS — Hot and Cold
SCREWDOWNS — Motor Operated • Hand Operated
SHEARS — Alligator • Bar • Billet • Bloom • Continuous Automatic • Sheet Mill • Gate or Guillotine • Lever • Plate • Power Driven • Scrap • Vertical
STRAIGHTENERS — Angle • Bar • Rails and Shapes
TABLES — Blooming Mill • Rolling Mill Feed • Transfer for Mills



LEWIS Standard Roll Lathe, Floor-mounted Motor



LEWIS 4-High Finishing Mill



LEWIS 17 Stand Rod Mill
view looking toward finishing end

YOU USE 4 + 8

YOU GET 100,000

That's all it takes! Four basic circuits and 8 basic component parts give you more than 100,000 different electronic instrument combinations for processing use.

Flow, level, speed, pressure, temperature, gas analysis, pH, conductivity, etc.—all can be controlled with these interchangeable Bailey units.

With Bailey controls, replacement part stocks are held to a minimum because parts are interchangeable. Maintenance costs are less, too, because maintenance men quickly become familiar with the standardized Bailey units.

Bailey bulletin No. 17 shows how you can use this improved control system. Write for your copy and keep it handy for reference the next time you need process controls.

P-19

BAILEY METER CO.
1047 Ivanhoe Rd. • Cleveland 10, Ohio
BAILEY METER CO. LIMITED, MONTREAL
Controls for the Steel Industry
TEMPERATURE • FLOW • PRESSURE
GAS ANALYSIS • LEVEL • RATIO

4 + 8 Works Here at the Irvin Works of the Carnegie-Illinois Steel Corporation.

HOW TO BEAT

the high cost of

Removing Dangerous Fumes

—use "Buffalo"

RUBBER LINED EXHAUSTERS

(their rubber lining on all parts of the fan exposed to corrosive fumes increases their life 3 to 12 times over all-metal fans.)

WRITE FOR BULLETIN 2424-E for most up-to-date developments and engineering facts on low-cost fume removal for better production.

Latest Answers to your AIR PROBLEMS!

FAN ENGINEERING

A Wealth of Engineering facts on . . .

- fans
- air flow
- sound laws
- air properties
- humidity
- heat
- heat transmission
- drying
- cooling
- many other facts

PRICE $6.00 ORDER NOW!

Are corrosive fumes robbing any of your departments of valuable production hours?

Exhausters can remove the fumes — but ordinary metal housings and wheels are quickly destroyed by fumes from many chemical processes.

"Buffalo" has been answering this problem ECONOMICALLY on thousands of chemical installations with rubber-lined fans. These are high-efficiency exhausters with rotors and entire interior surface of housings coated with rubber by the "Vulcalock" process. FUMES CANNOT COME IN CONTACT WITH METALS.

Call in your "Buffalo" representative and talk over this money-saving answer to YOUR Fume problem!

"Buffalo" MACHINE TOOLS

BUFFALO FORGE COMPANY

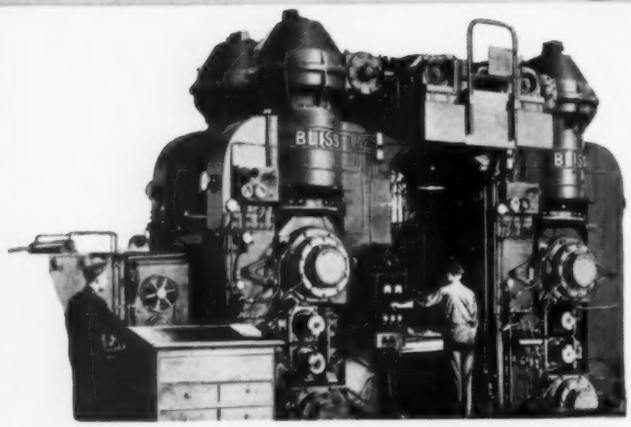
173 MORTIMER STREET BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

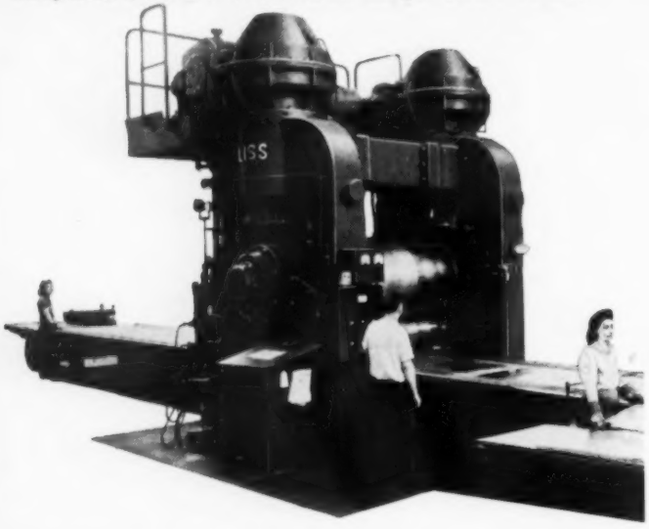
Branch Offices in all Principal Cities

DRILLING PUNCHING SHEARING

In Rolling Mills, too,



BRASS—16" x 34" x 34" two stand tandem four-high mill is one of many Bliss installations used for breaking down brass slabs.

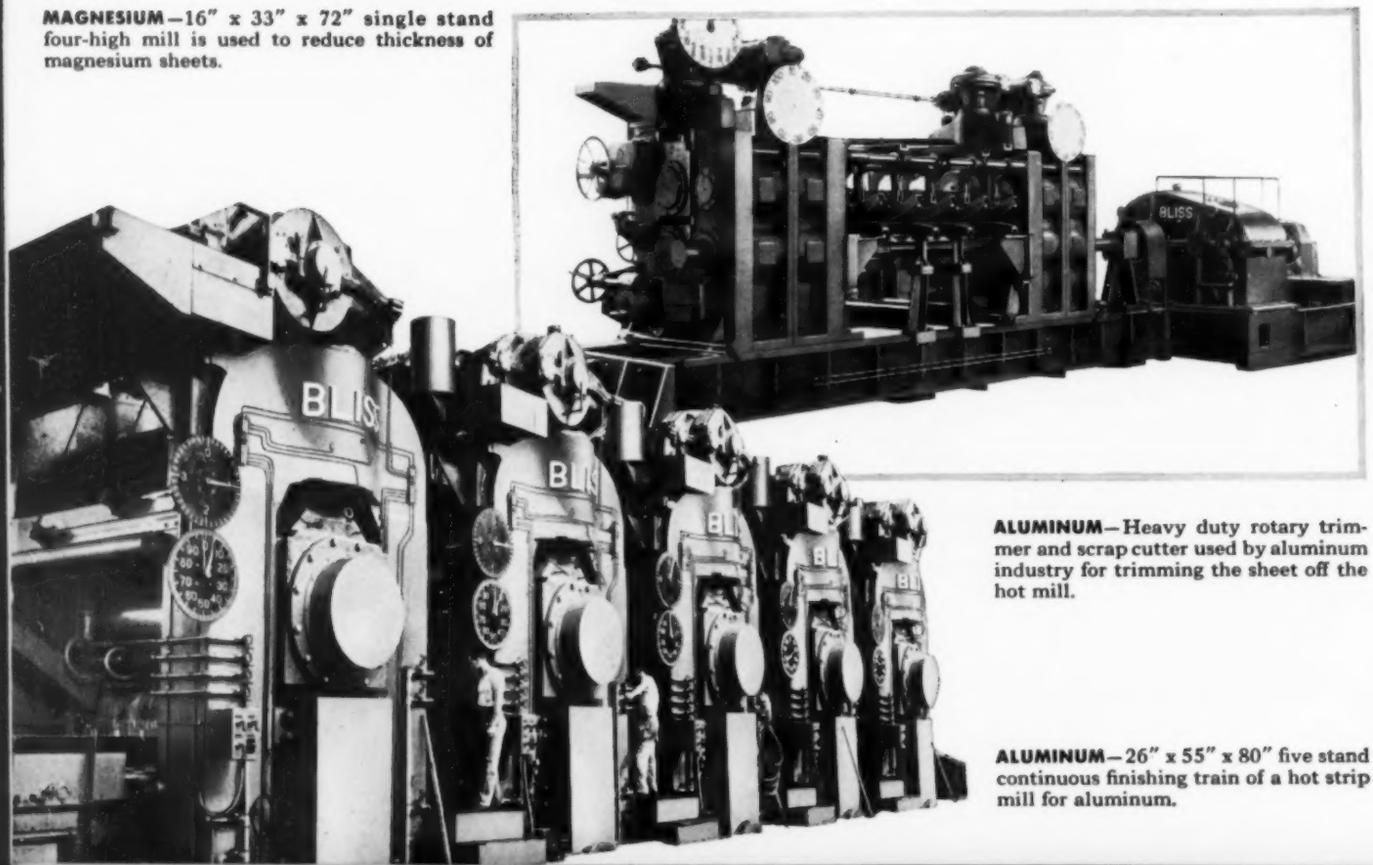


MAGNESIUM—16" x 33" x 72" single stand four-high mill is used to reduce thickness of magnesium sheets.

Hundreds of outstanding Bliss sheet and strip mill installations—here and abroad—give daily evidence of the close cooperation between customer and builder which alone can create a mill exactly suited to the job at hand.

Whether your requirements concern 2-, 3-, 4-high or cluster mills; hot or cold-rolling of ferrous or non-ferrous metals, Bliss can supply the equipment especially designed to suit *your* needs. Bliss also builds an extensive variety of accessories: mandrel type hot mill coilers, up-coilers, slitters, etc. Some of this equipment are illustrated on these pages.

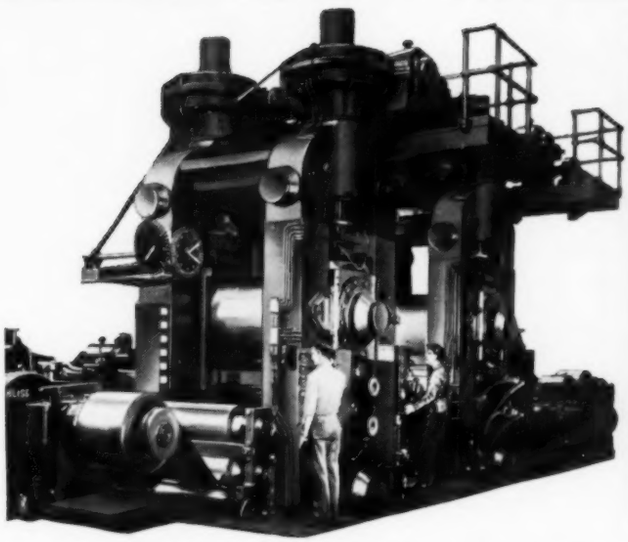
Put your rolling mill problem up to Bliss. You'll find the same keen engineering counsel and service which have made Bliss the first name in presses for more than 90 years.



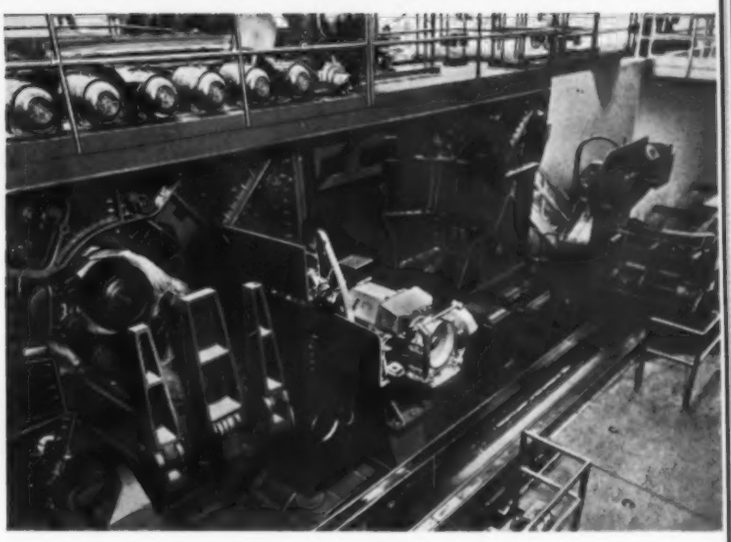
ALUMINUM—Heavy duty rotary trimmer and scrap cutter used by aluminum industry for trimming the sheet off the hot mill.

ALUMINUM—26" x 55" x 80" five stand continuous finishing train of a hot strip mill for aluminum.

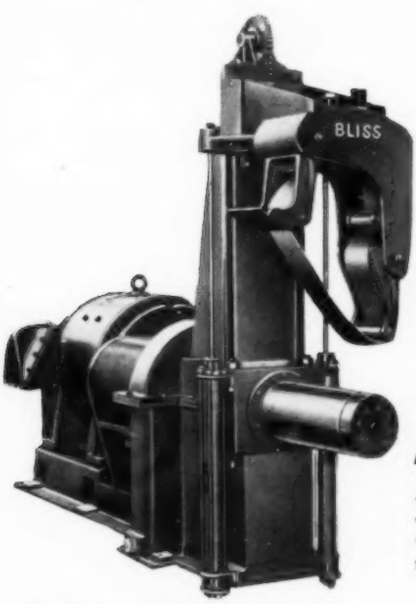
Stay Ahead with Bliss



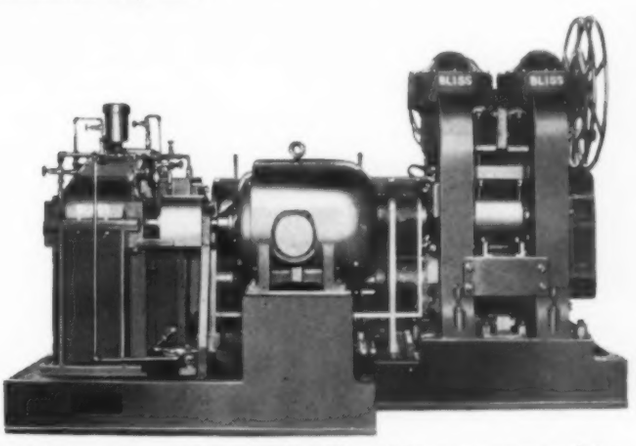
TIN PLATE—18" x 42½" x 42" two stand tandem temper pass mill for tin plate.



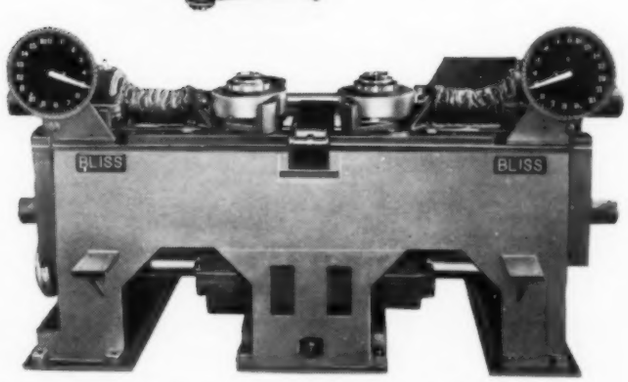
STEEL—Improved type hot strip downcoiler and upender for a Bliss 48" continuous strip mill.



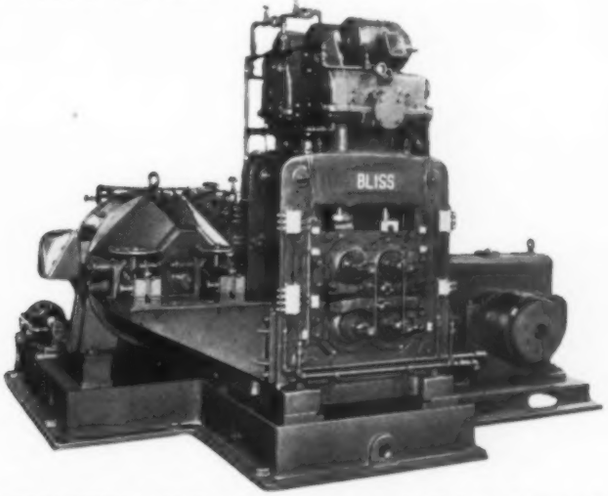
ACCESSORY—12" x 18" tension reel with vertical type belt wrapper has application in ferrous and non-ferrous fields.



COIN METAL—14" x 12" two-high mill used in government mints—typical of smaller Bliss mills.



ACCESSORY—20" Vertical edger for edging 8" to 40" wide slabs.



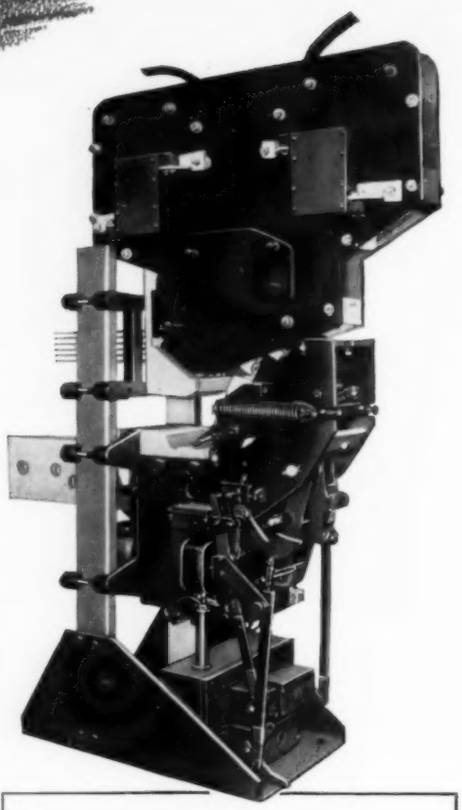
THIN GAGE METALS—3¼" x 9" x 8" Cluster Mill for cold reducing high carbon alloy and stainless steels from gages of .125" to .004".

E. W. BLISS COMPANY

450 AMSTERDAM AVENUE, DETROIT 2, MICHIGAN

STAY AHEAD WITH *Bliss*

Rolling Mills...Mechanical and Hydraulic Presses...Container Machinery



TYPE MT — for pedestal mounting. Single pole, electrically operated. Application: 250 and 750 Volts. Interrupting rating is 150,000 Amp. in continuous ratings 2000 and 4000; 250,000 Amp. in continuous ratings 6000 and above.

Electrical disturbances can't spread trouble with this *more dependable, better built* breaker on the job!

● Short circuits and extremely heavy overcurrents don't have a chance to ruin your essential generators, motors, rectifiers, and connected production equipment—when your electrical distribution system is protected by proper application of I-T-E Type MT Automatic Reclosing Circuit Breakers.

The MT was specially developed by I-T-E—*Switchgear Specialists*—for interrupting extremely heavy direct currents. It breaks a circuit in .028 seconds (about 1¾ cycles on a 60 cycle basis) at 25% to 100% of interrupting capacity. I-T-E's *Rate-of-Current-Rise* Trip anticipates extremely heavy currents—distinguishes between a useful load of high value and a dangerous fault current—and trips the breaker before the danger peak is reached. Shorts and overcurrents are cleared instantly, dependably, before they have a chance to cost you money.

And with the MT breaker, you get an exclusive I-T-E "extra" —*better design* to give you the benefits of manufacturing savings which, in turn, allow higher-quality refinements *at no extra cost*.

Complete details on the I-T-E Type MT Air Circuit Breaker (including Automatic Reclosing Applications) are contained in illustrated catalog 2202. Send for your copy.

ARC EXTINCTION IN THE MT AIR BREAKER

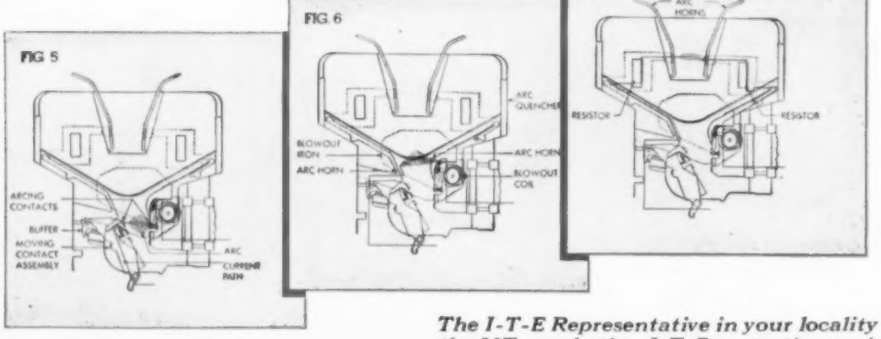


FIG. 5 First stage in circuit interruption: Arc drawn between arcing contacts; blow-out coil in circuit.

FIG. 6 Second stage: Arc transferred to arc horns.

FIG. 7 Final stage: Arc transferred to secondary arc horns; resistors in circuit.

The I-T-E Representative in your locality will be glad to advise you on applying the MT—and other I-T-E protective equipment—to your electrical distribution system. Use his services without obligation.

I-T-E R&IE *

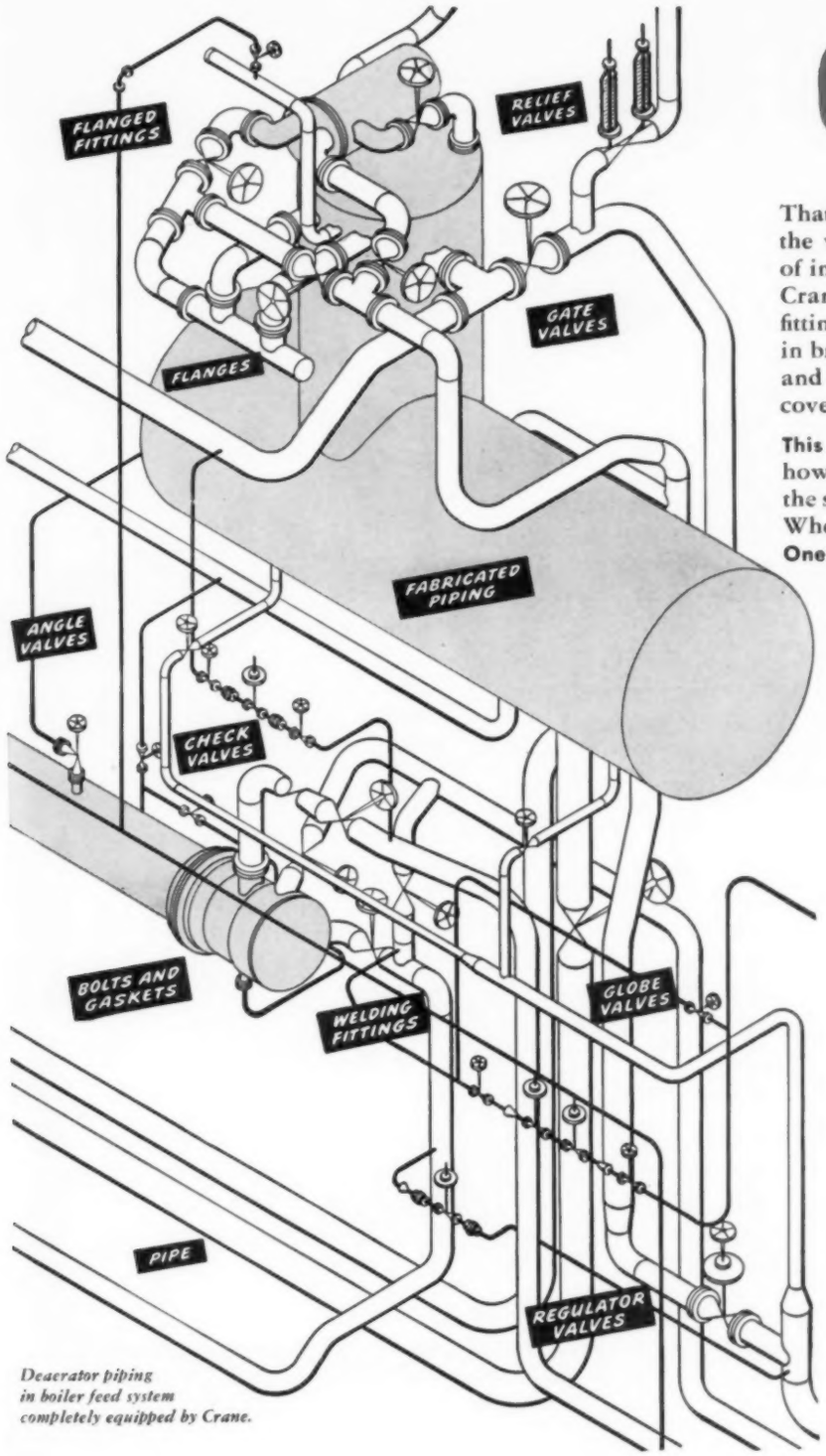
MILL TYPE SWITCHGEAR

The Leader In Technical Excellence

I-T-E CIRCUIT BREAKER CO., 19th & HAMILTON STS., PHILA. 30, PA. — 31 OFFICES IN THE UNITED STATES
In Canada, EASTERN POWER DEVICES, Ltd., TORONTO

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • AUTOMATIC RECLOSING CIRCUIT BREAKERS • HIGH SPEED CIRCUIT BREAKERS
*FOR POWER SWITCHING EQUIPMENT, REFER TO RAILWAY AND INDUSTRIAL ENGINEERING CO., AN I-T-E SUBSIDIARY

Everything in piping . . . for every need
. . . on one order to CRANE



Deaerator piping in boiler feed system completely equipped by Crane.

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

That's the kind of service you get from Crane, the world's leading manufacturer and supplier of industrial piping equipment. "Everything" at Crane includes an unequalled selection of valves, fittings, fabricated piping, pipe and accessories—in brass, iron, steel and alloys. One catalog . . . and one order to your nearest Crane Branch cover whatever is needed for the job.

This Deaerator Piping, for example, illustrates how completely Crane supplies everything for the system, regardless of the fluids to be handled. When you standardize on Crane, you depend on **One Source of Supply** broad enough to simplify every piping procedure. You get better installations . . . avoid needless delays . . . by placing **Undivided Responsibility** on Crane for materials. And for **Highest Quality** in every piping item, specify Crane Quality—unsurpassed for more than 90 years.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

FOR TOUGH STEAM SERVICES *up to 750 deg. F., and for water, oil, air, gas and other non-lubricating liquids up to 500 deg. F., Crane recommends No. 47XR 150-pound Cast Steel Wedge Gate Valves. Designed for tight seating with long-lasting Exelloy to Nickel Alloy. Screwed, flanged or welding ends. Sizes: 2 in. and larger. See your Crane Catalog, p. 304.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

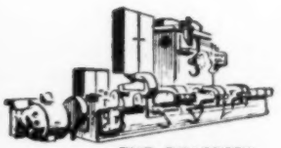
Still more Bonnot Billeteers are on the way to Europe to join those already speeding steel production for industrial recovery. Plants receiving the new Billeteers in the near future are located in Belgium, Luxemburg, Italy and France.

World-wide acclaim for the Billeteer lies in what the Billeteer is doing for every plant in which it is installed. The billet shed was once the bottleneck between furnaces and shipping docks. Today with Bonnot Billeteers, deep flaws can be cut out and remelting of billets is practically eliminated—there's a steady flow of clean billets to finishing mills. Operating records show a Billeteer handling 100 tons of billets per shift—removing up to 1½ tons of steel scrap—all flaws completely eliminated—all chips 100% reclaimable.

Just one operator handles the Billeteers easily during an 8-hour shift, doing the work of more than 10 hand chippers and without the fatigue and manpower turnover that results from more muscular methods of billet cleaning. Why not let the Bonnot Billeteer work for you? Write for information today!

Engineered for Improved Production

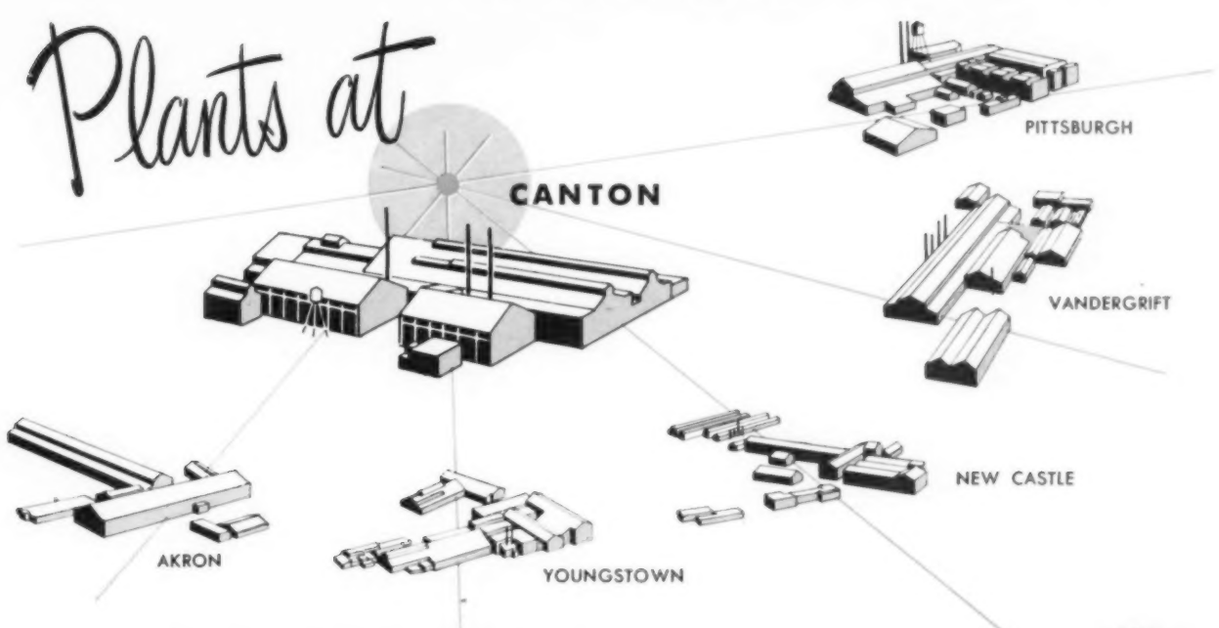
The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

ALSO MANUFACTURERS OF SAWING · CRUSHING · PULVERIZING & MIXING EQUIPMENT

View of Roll Shop .. Canton, Ohio plant



UNITED ENGINEERING AND FOUNDRY COMPANY

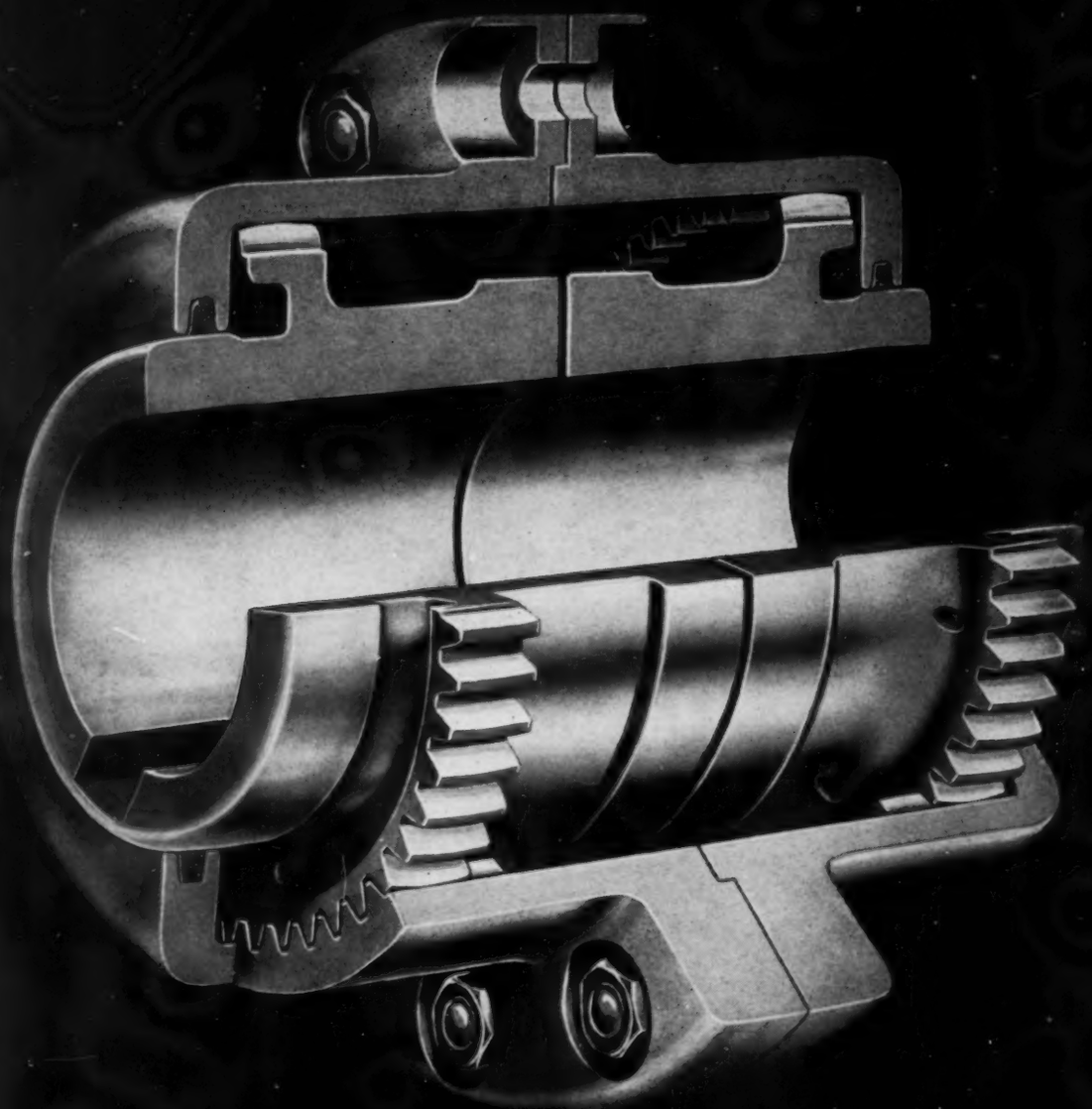
PITTSBURGH, PENNSYLVANIA

Subsidiary: Adamson United Company, Akron, Ohio. *Affiliates:* Davy and United Engineering Company, Ltd., Sheffield, England; Dominion Engineering Works, Ltd., Montreal P.Q. Canada; S. E. C. I. M., Paris, France

REG. T. M.

Designers and Makers of Rolls and Rolling Mill Equipment

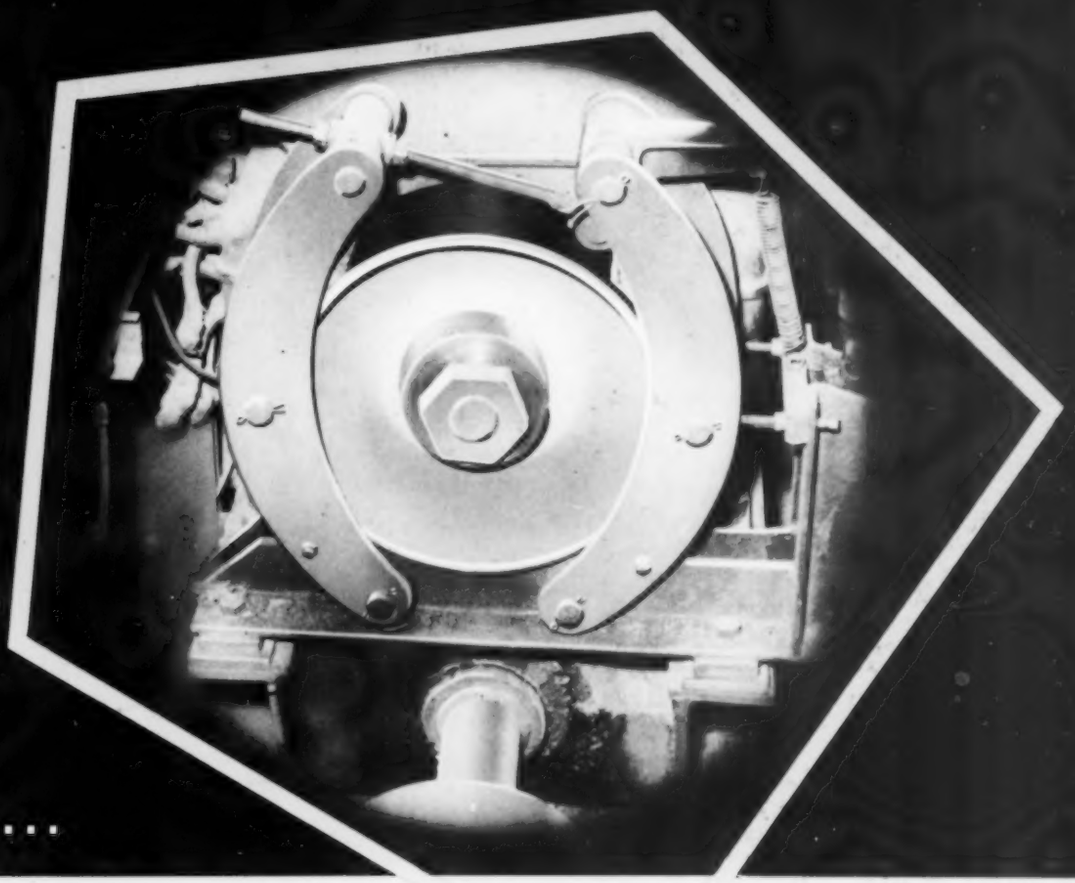
POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.



"TOOL STEEL" PROCESS

BRAKE WHEELS . . .

provide

GRANITE CITY STEEL COMPANY

with LONGER LIFE FEWER LINING CHANGES LOWER MAINTENANCE

"Tool Steel" brake wheels outlasted cast iron wheels on this hot strip mill crane drive by **22 times** . . increased brake lining life by **5 times!**

This superior quality which has found such high favor for "Tool Steel" brake wheels is also built into "Tool Steel" gears and pinions, wheels, rolls, and other "Tool Steel" hardened products!

WE GUARANTEE our products to give sufficient life over any other grade of hardened material operating in the same service to cover any difference in first cost. If our material fails to fulfill this guarantee, we will make good the deficiency in either cash or new material.

THIS GUARANTEE WAS ORIGINATED BY AND IS EXCLUSIVE WITH THE TOOL STEEL GEAR AND PINION CO.

HERE'S GRANITE CITY'S COMPARISON:

	"TOOL STEEL" WHEELS	CAST IRON WHEELS
SERVICE LIFE:	22 Months (Continuous) *	1 Month Average
BRAKE LINING LIFE:	45 Days (Average)	9 Days Average

* These "Tool Steel" brake wheels were removed after 22 months, reground and placed in service on another crane!

This service life can be equalled by no other products! Write today for complete information.

"TOOL STEEL" PROCESS

The Standard of Quality

for GEARS • PINIONS • ROLLS • WHEELS *and other* HARDENED PRODUCTS

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI 16, OHIO, U. S. A.

PARALLOY

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PINCH ROLLS
COILER ROLLS
TENSION ROLLS
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MACHINERY BUILT TO CUSTOMER'S

DESIGN AND DETAIL DRAWINGS

The Youngstown Foundry & Machine Co.

YOUNGSTOWN, OHIO

WHEN YOU'RE FIGURING CABLE COSTS* USE THESE FACTS ON FILE ABOUT OKONITE

4700 feet of Okonite Underground Cable in service since 1908..... Removed and Re-Used in 1948

2000 feet of Okovar Varnished Cambric Cable Installed Overhead and put in service in 1927..... Removed and Re-Used in 1948.

***with today's installation costs only the *Longest-Lived* will be economical . . . . . .**

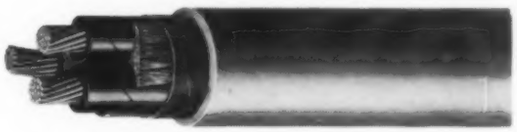
The lifetime cost of a cable rather than its first cost is the only true measure. Okonite wires and cables, built to stand up better and longer, can offset high installation costs.

In the files of The Okonite Company are a number of case histories that tell their own story of the long life—the real yardstick of cable economy—that you can count on with Okonite. The two instances cited above are from the records of a single customer.

They are two of eleven instances of cables long used and transferred to new locations by this customer, who has re-installed more than 24 miles of such Okonite cable.

Building true value into cable has been Okonite's business since 1878. What goes into an Okonite cable to make it do a better job...what tests it must pass...what care is taken to control its electrical characteristics—all this and other data are found in Research Bulletin IS-101. For a copy, address The Okonite Company, Passaic, New Jersey.

Okonite rubber insulated lead-covered underground cable.

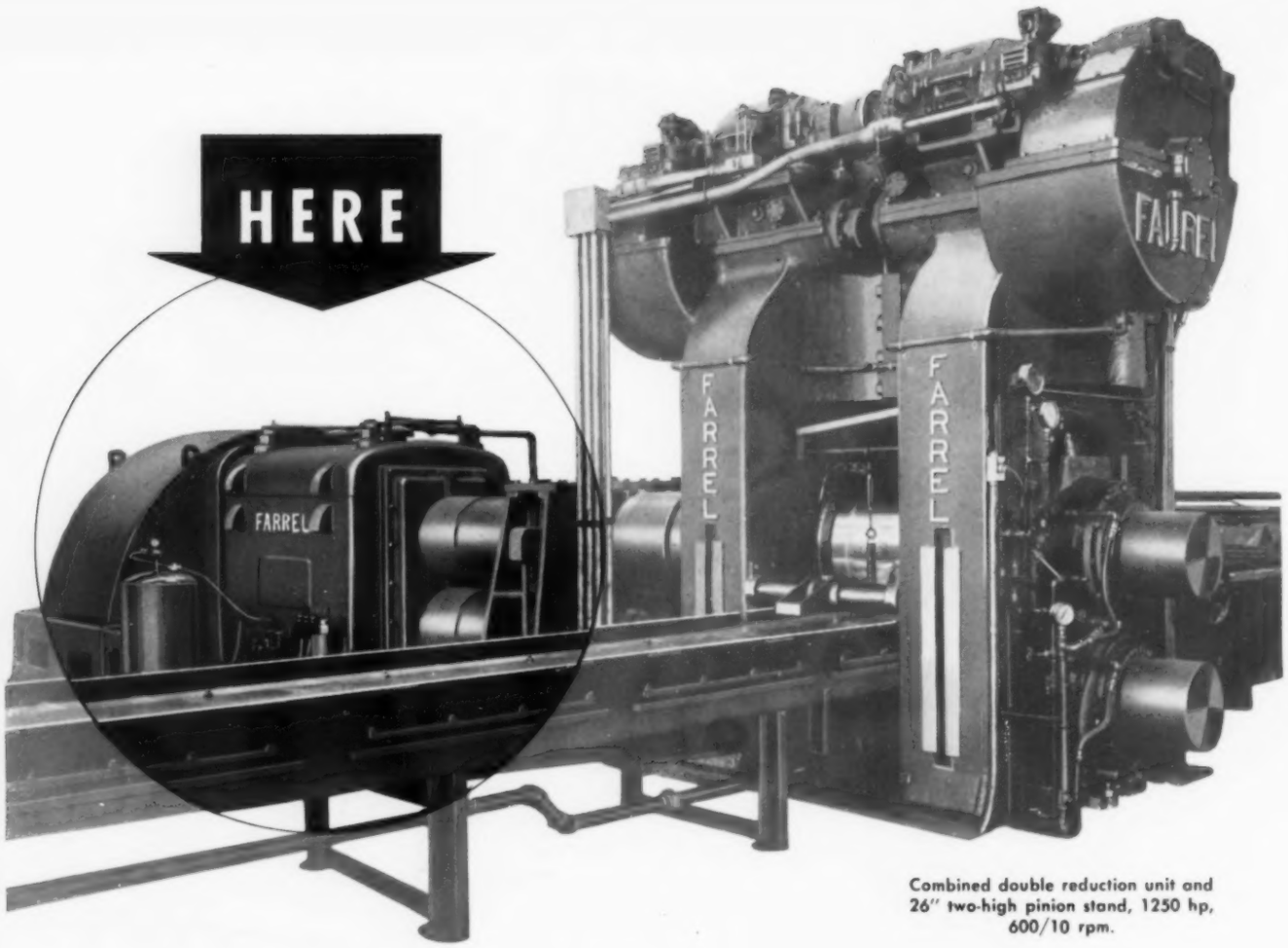


Okovar varnished cambric lead-covered aërial power cable.

THE BEST CABLE IS YOUR BEST POLICY

7421

OKONITE SINCE 1878 *insulated wires and cables*



Combined double reduction unit and 26" two-high pinion stand, 1250 hp, 600/10 rpm.

. . . you need a perfect "partner" for your mill

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Rolls
Rolling Mills
Rod Mill Tables and Manipulating Equipment
Universal Mill Spindles
Rod Coilers
Gears
Mill Pinions
Pinion Stands
Gear Drives of Any Capacity
Flexible Couplings
Roll Grinding Machines
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Lead Presses for Pipe or Rod

The combination gear drive and pinion stand that delivers power from the motor to your mill should give trouble-free power teamwork, year after year. To do this it must be fitted to the job. That's where Farrel engineers come in—to give you a unit designed for your mill.

All you have to do is to provide us with the drive requirements: Power and speed . . . type and gauge of metal to be rolled . . . process (hot or cold) . . . nature of load (continuous or intermittent) . . . type of drive motor . . . etc. We will then supply you with a unit that has been *engineered for the job* it will have to do.

Call us when you want a drive designed and built for continuous, trouble-free operation. Our engineers will be glad to discuss gear drive problems with you at any time, without obligation. Why not call on them?

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Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston

FB-527

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"The Home of Good Bearings"—LINK-BELT Dodge Plant
519 North Holmes Avenue, Indianapolis, Indiana

Meeting industry's ever-increasing demands for ball and roller bearings that offer the desired combination of free-rolling action, self-alignment, and long life is no small-sized job.

That's why the entire capacity of Link-Belt's Dodge Plant in Indianapolis is devoted to this important task.

From the receipt of housing castings furnished by sister plant foundries to shipment of finished mounted bearings, alert design engineers, skilled craftsmen and the most modern bearing production machinery work hand-in-hand to turn out the bearings that enable users to TURN SHAFTS EFFICIENTLY.

Cut-away view of Series 200 Ball Bearing Pillow Block

LINK-BELT COMPANY

Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Distributors in Principal Cities

11,387

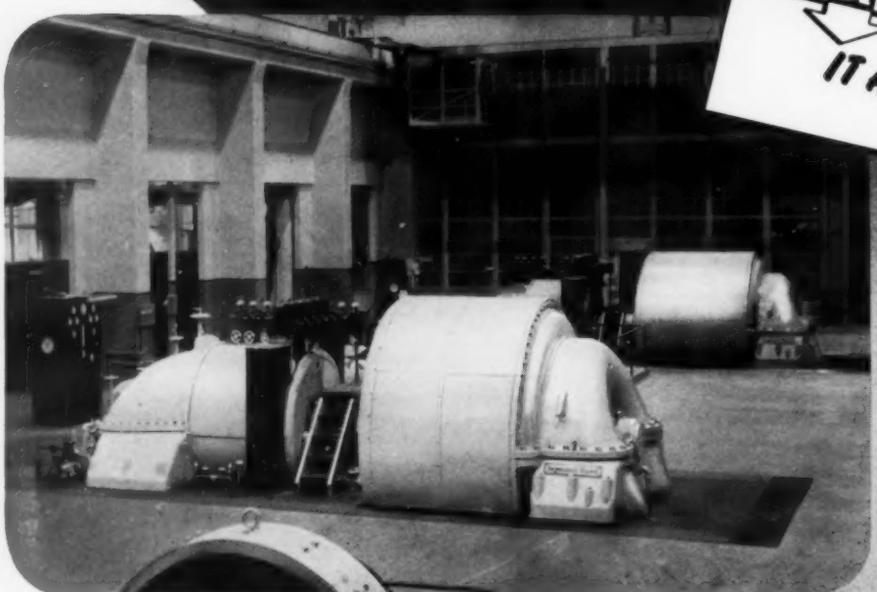
LINK-BELT — *Ball and Roller BEARINGS*

If you're buying a blower....

Specify I-R for

LOW POWER COST — Money Saved
LOW MAINTENANCE COST — Money Saved
HIGH AVAILABILITY FACTOR — Money Earned

IT ALL ADDS UP!



for HANDLING AIR AND GAS THERE IS A PREFERENCE for I-R BLOWERS

Blast Furnace Blowing

A user writes that after a continuous run of 6 years, one of our blast furnace blowers was opened up for inspection ... and it was in perfect condition! This meant that maintenance costs were zero and availability was 100%. Performance like this is one of the reasons steel men prefer I-R blowers.

Gas Pipeline Transmission

The new centrifugal pipeline boosters for the Big and Little Inch pipelines were specially designed and built by Ingersoll-Rand. This is the latest of many I-R "firsts" in designing special blowers for special jobs.

Gas Distribution

You will find Ingersoll-Rand blowers being used as manufactured gas boosters and exhausters for gas distribution in cities such as New York, Newark, Los Angeles, Chicago, Philadelphia, Detroit, Washington, Boston, Buffalo.

Refinery Service

In refineries too, there is a preference for I-R Blowers. The Ingersoll-Rand line offers operators a complete range of single and multi-stage turbo-blowers for catalytic cracking units and other refinery services where this type of compressor is the best solution to the problem. Sizes to 21,000 hp for capacities to 140,000 cfm.

Cupola Blowing

Hundreds of I-R cupola blowers with constant-air-weight control have paid for themselves through savings in coke alone. No wonder there is such a wide preference for I-R blowers among foundrymen.

COMPRESSORS • AIR TOOLS • ROCK DRILLS
TURBO BLOWERS • CONDENSERS
CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 225-12

MORGAN WORCESTER ROLLING MILLS

56 MORGAN MERCHANT MILLS
roll out high tonnages, accurately, at low cost
MORGAN CONSTRUCTION COMPANY
SPEAKING OF ACCEPTANCE
63 Morgan Billet Mills
are here
there
everywhere
MORGAN CONSTRUCTION COMPANY
18 MORGAN STRIP and SKELP MILLS are promoting recovery in five countries
MORGAN CONSTRUCTION CO.
39 MORGAN ROD MILLS operate efficiently in ten countries
MORGAN CONSTRUCTION CO.

198
on the job*
. . more on the way

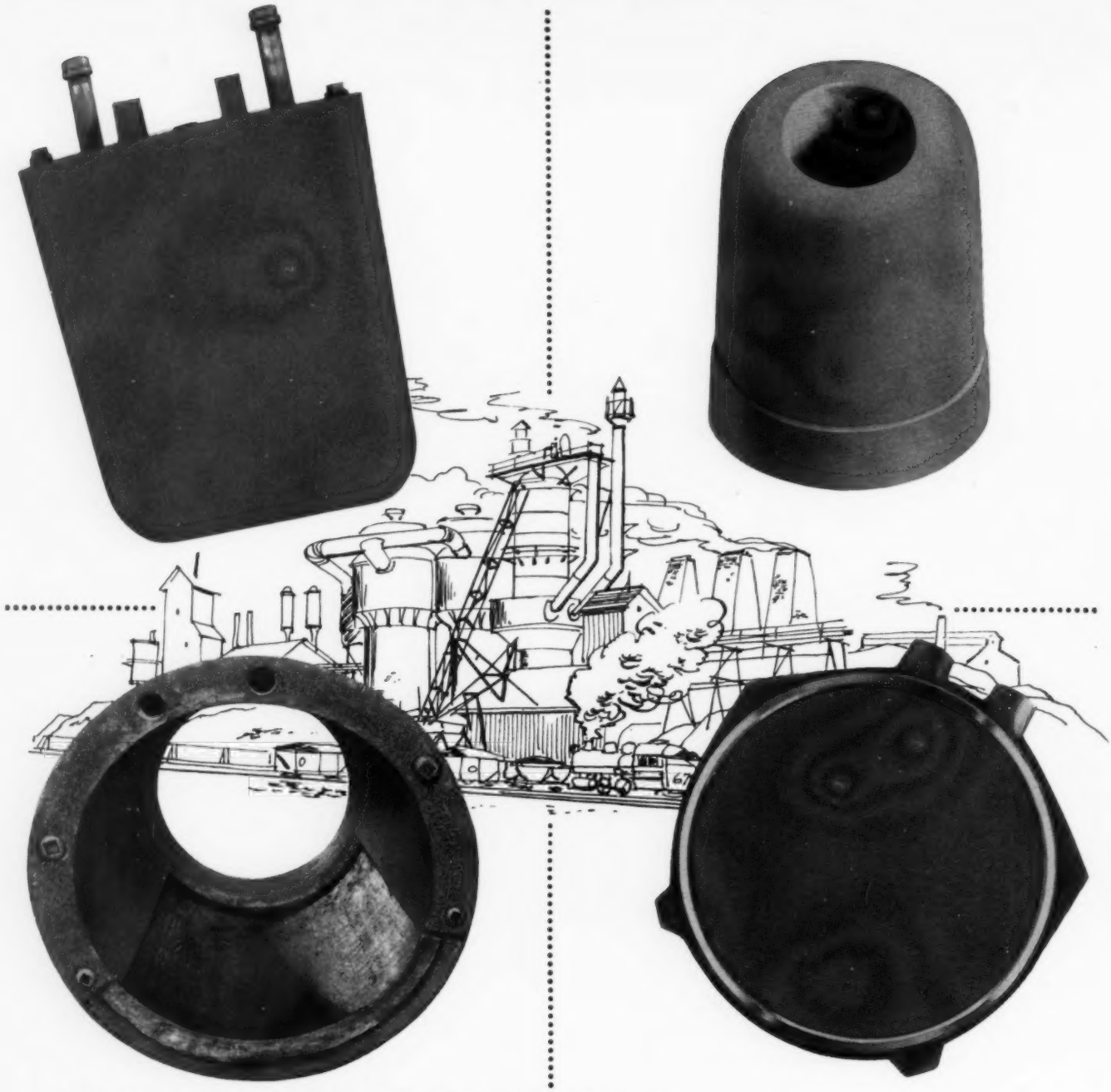
A high percentage of the world's output of billets, rods, merchant shapes, strip and skelp is rolled on Morgan mills.

Morgan achieved preeminence in the field by introducing the first successful continuous rolling mill and has retained leadership through a steady stream of technical advancements.

No two Morgan Mills are exactly the same. Each was engineered to meet specific needs. Each fulfilled its purpose a little better than its predecessor.

With 198 mills and 60 years behind us we are ready to apply what we have learned to *your* problem. Why not write us today to talk it over? RM-16

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS
English Representative: International Construction Company
56 Kingsway, W. C. 2, England
*This includes 22 mills of types not illustrated.



N-B-M COPPER CASTINGS . . . the right answer

for greater production between stack shutdowns

N-B-M Copper Castings are the result of improved alloying and close foundry control perfected in our metallurgical and engineering research laboratories. These castings provide greater heat resistance for your most troublesome burn-out points, greater production between stack shutdowns. Always specify N-B-M Copper Castings—they give you longer, more economical service.

★

A COMPLETE LINE OF N-B-M CASTINGS

- Cinder Notch Coolers
- Bosh Plates
- Monkeys
- Stack Plates
- Tuyeres
- Tuyere Coolers
- Valves
- Valve Plugs
- Valve Seats
- Phosphorized Copper

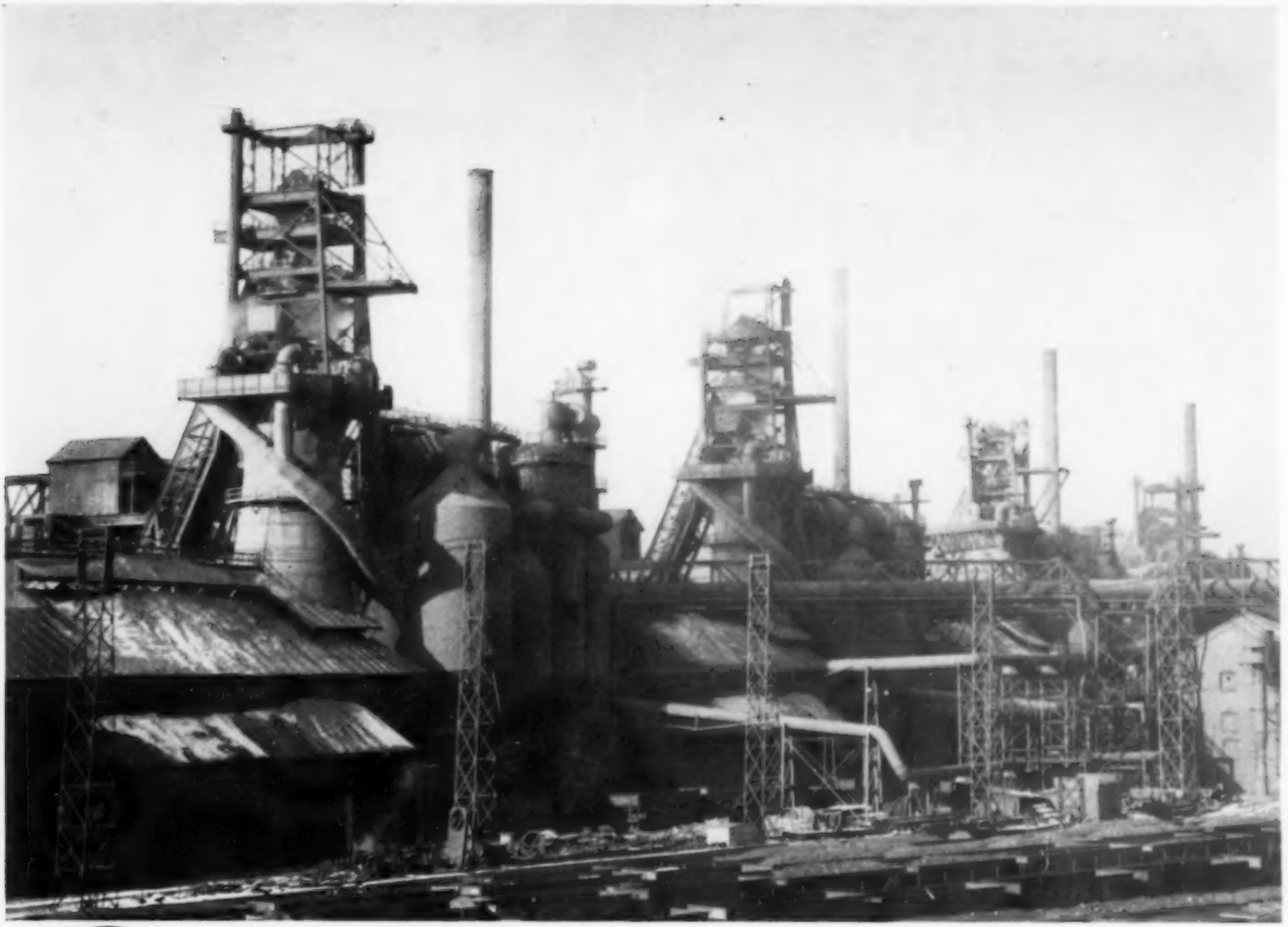
N·B·M

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

ST. LOUIS 10, MO. • MEADVILLE, PA.

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.



Designed, BUILT and ERECTED BY POLLOCK

. . . PIONEER IN STEEL PLATE CONSTRUCTION WORK

● When you are considering expenditures for blast furnace work, be it a complete rebuild, enlargement, or just a minor repair job, get the best for your money—contact **The William B. Pollock Company. Pollock's** skilled experts have been designing, engineering, fabricating and erecting all types of blast furnace and stove steel construction since 1863.

You can profit—as many others have—from **Pollock's** world-wide experience . . . its complete facilities and well-trained engineering-designing staffs. When you think of blast furnace work, think of **Pollock**—for furnace shells, stoves, dust catchers, washers, piping, skip bridges, platforms, cast houses, bells, hoppers, and miscellaneous valves.

Call or write today for complete information and descriptive literature.

POLLOCK

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN · OHIO
STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES

new "twin-motor" temper mill drive holds tension accurately at 3700 fpm!

G-E engineered drive paves the way for higher rolling speeds and greater production of quality steel

Here is another fine example of General Electric drive engineering and how it can save time and money for steel operators. It is the recently developed twin-motor drive for a two-stand temper mill. It combines all the advantages of twin motors on each stand with an exceptionally accurate method of controlling tension between stands.

Trial tests showed that the new mill can be operated as fast as 3700 feet per minute and still have strip tension between stands within close limits. Key to the success of the new drive is a unique combination of amplidyne control and a high-accuracy General Electric regulating tensiometer. The drive on this new mill also maintains tension accurately between the stands and the pullers as well as between the pullers and reels by use of conventional amplidyne current control.

Specifically, this new General Electric temper-mill drive provides the mill operator with these important advantages:

● *It enables the operator to compensate electrically for unequal roll diameters, thus eliminating the necessity for exactly duplicating work-roll diameters.*

● *It eliminates pinion stands and the expense of maintaining them.*

● *Most important, it reduces inertia, thereby permitting the mill to be accelerated or decelerated more rapidly with accurate control of tension to provide increased production of high-quality steel.*

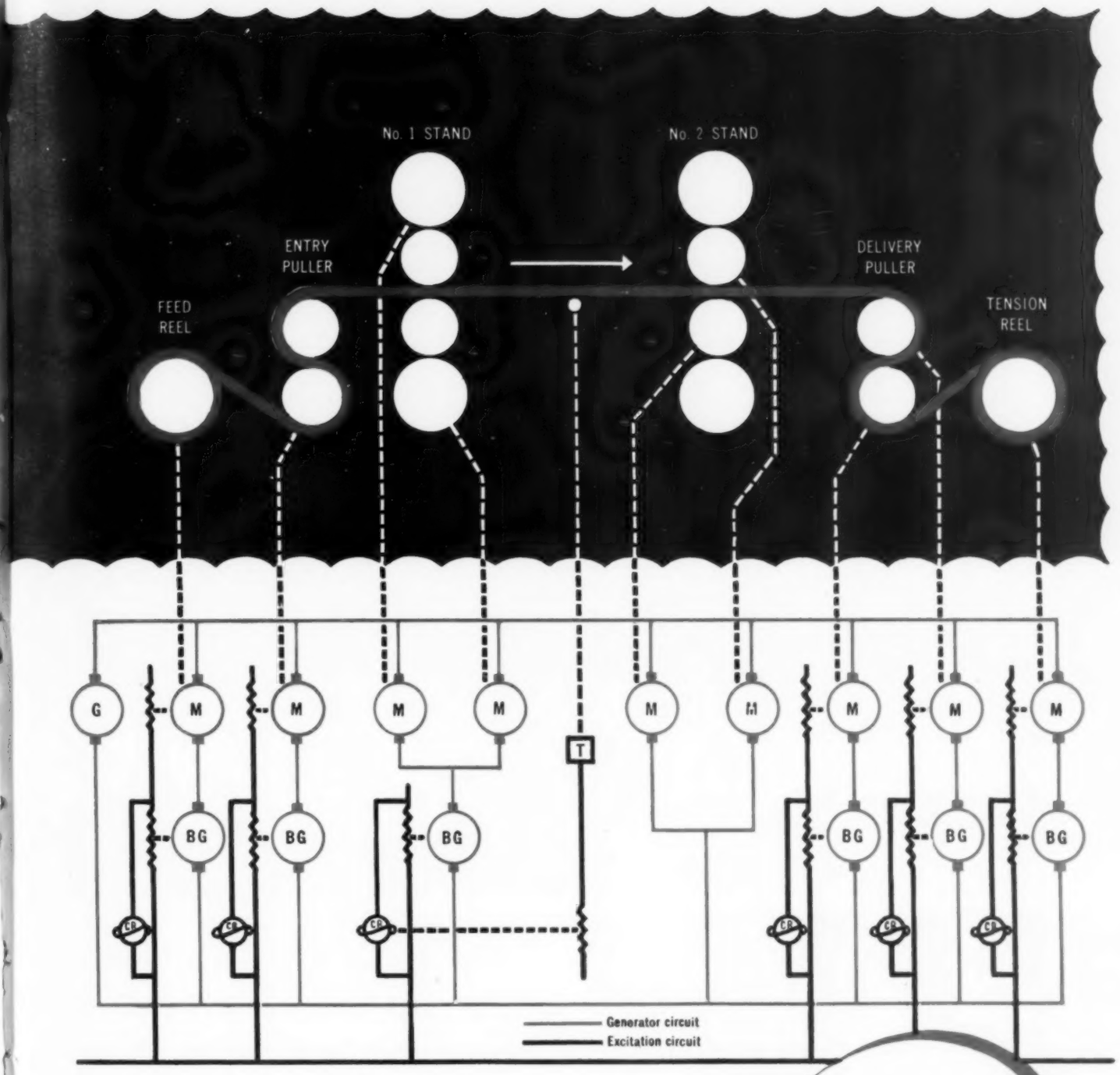
Because this General Electric drive is engineered and installed as a unit, you are spared the trouble and expense of co-ordinating all the components of modern mill drives—motors, controls, cable and power distribution equipment. General Electric makes sure that every equipment selected is the right one for the job, and assumes responsiblity for securing delivery of all the electrical components. Until the drive is installed and running smoothly, a G-E steel-mill specialist's help and experience are freely available. Why not consult the steel-mill specialist in your local General Electric office on your drive problems *now? Apparatus Department, General Electric Co., Schenectady 5, N. Y.*

A QUICK EXPLANATION *of this new mill drive!*

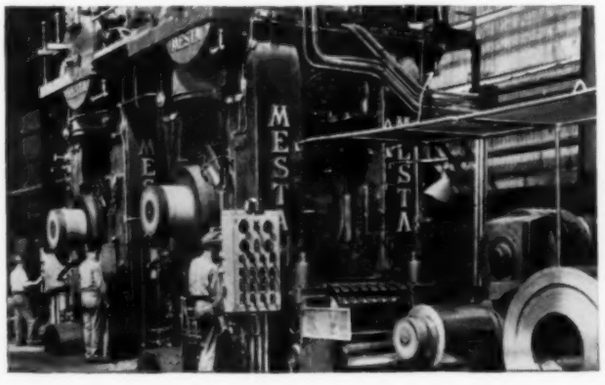
Strip tension between the No. 1 and No. 2 stands of this temper mill is measured by a regulating tensiometer (T). As tension tends to rise or fall below a pre-set value, the strip exerts a varying pressure on the tensiometer roll. This is translated into an electrical signal and transmitted to a General Electric amplidyne (CR). The latter functions as a regulating exciter. It amplifies the control signal and uses it to vary the excitation of the booster generator (BG) in series with d-c motors (M) driving the No. 1 stand. As tension tends to decrease, the excitation power decreases, the motors on the No. 1 stand slow down and exert an additional drag on the steel strip. As tension tends to increase, the amplidyne increases the booster generator excitation, thereby increasing motor speed and restoring the tension to its normal value. The main generator is shown as (G). Tension is maintained between the reels and pullers as well as between the pullers and stands. An electrical signal is fed into separate amplidynes which vary the excitation of the motors on each reel and roll.

GENERAL ELECTRIC

659-66



With G-E amplidynes and regulating tensiometer, this mill can be operated as fast as 3700 feet per minute

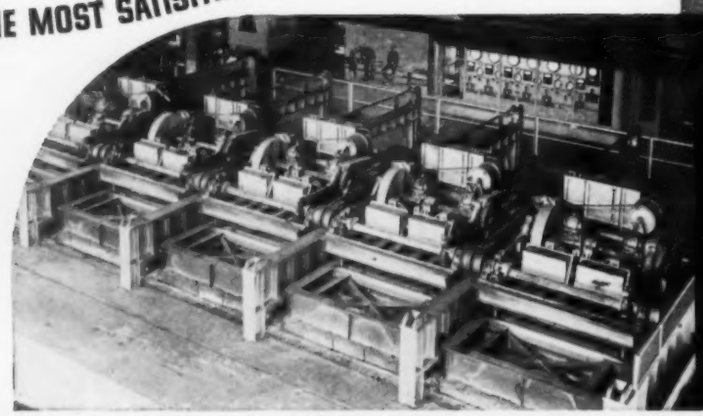


another example of GENERAL ELECTRIC drive engineering at work!

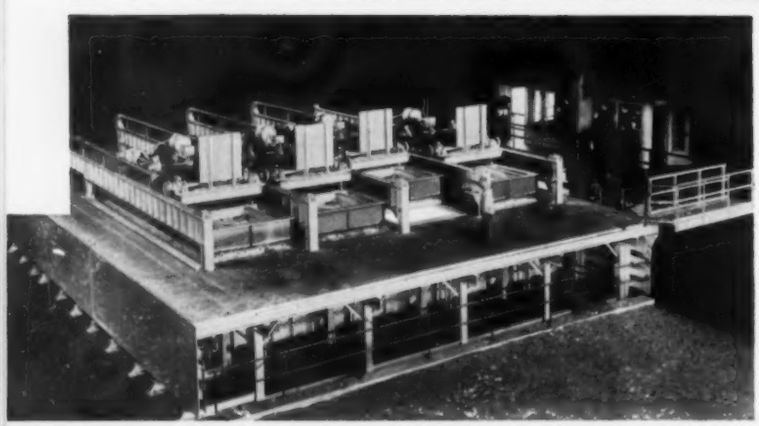
WE'VE BEEN ENGINEERING

THE MOST SATISFACTORY METHOD OF INGOT HEATING

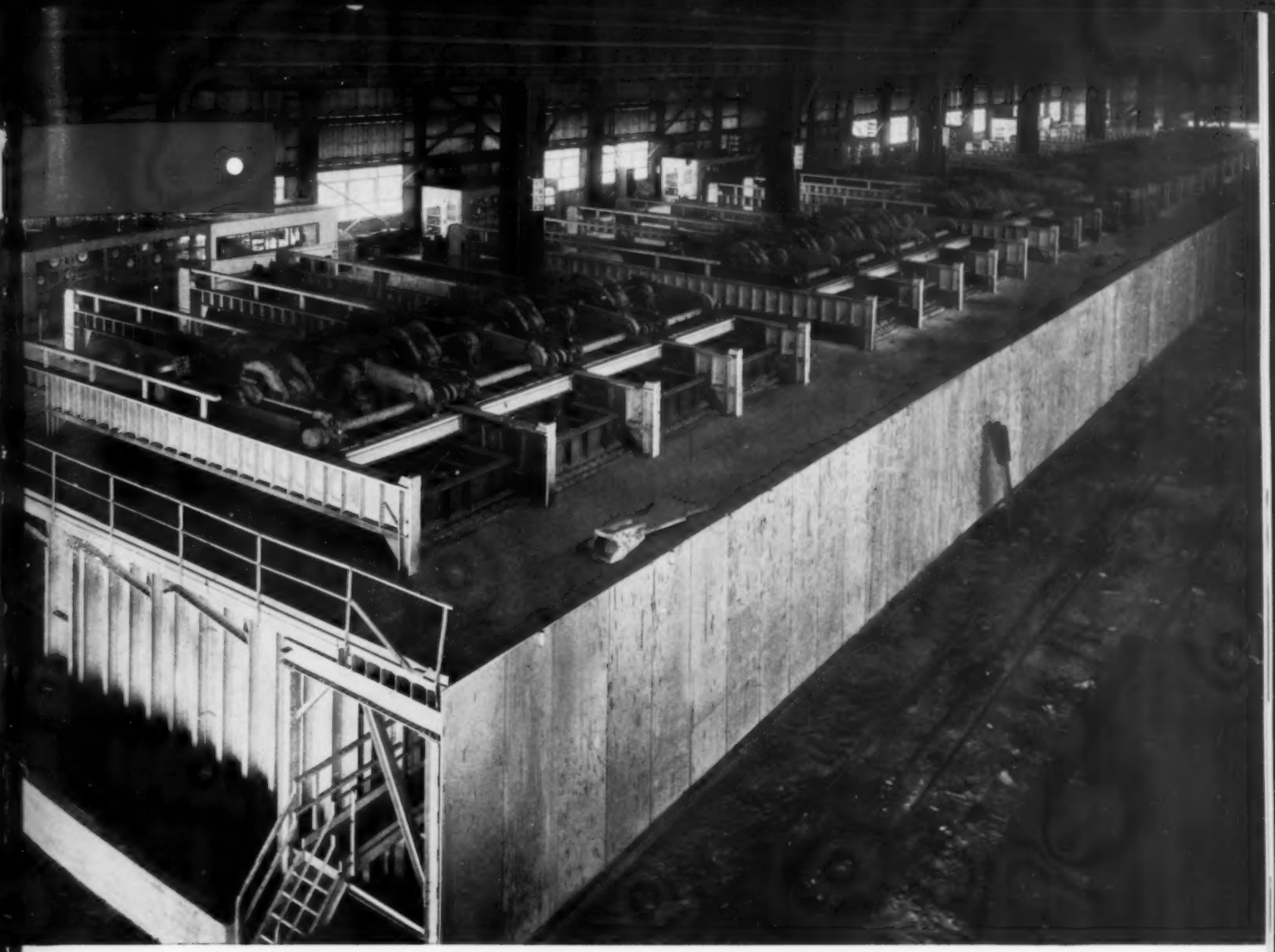
'SURFACE' ONE-WAY FIRED PITS



*FOR 23 YEARS!



*Ever since the first 'Surface' One-Way Fired Soaking Pit was installed in 1926, our engineers have been working with steel men in a program of continuous development of heating equipment to meet the prevailing metal production need.



Today, Surface One-Way Fired Soaking Pits incorporate the most modern features in design and operation to make possible high quality as well as quantity tonnage.

During the 23-years of 'Surface' Pit engineering the One-Way Firing principle has remained the most satisfactory method of ingot heating. It is convincing to see 'Surface' Pits in operation.

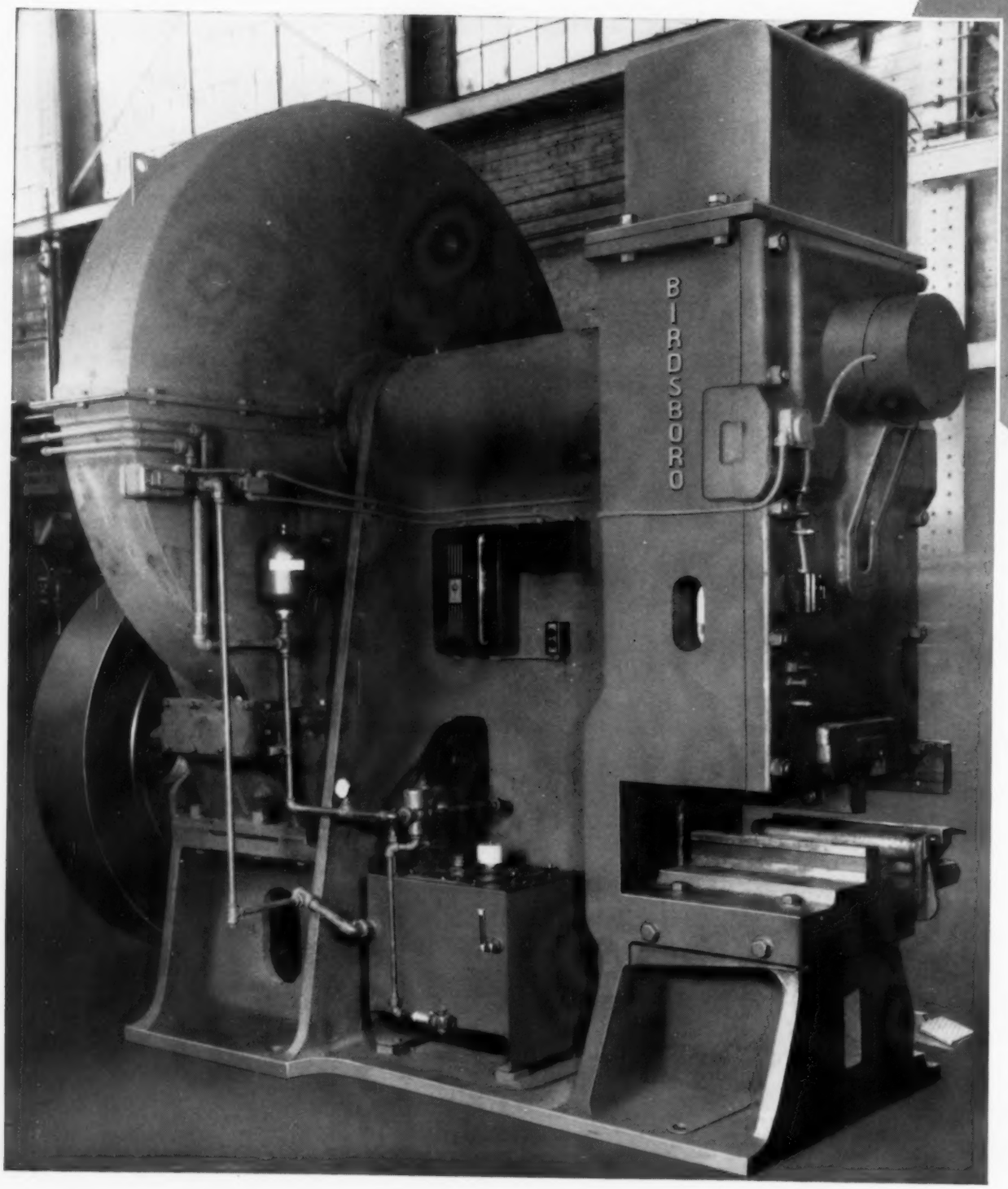
Furthermore, 234 One-Way Fired Pit installations have been made since 1936...155 since 1942...indicative of an industry trend to proved heating methods and equipment. These installations are to be found in the plants of 21 leading steel companies, and there are as many as 64 pits representing 11 repeat orders in 22-years, at one company alone.

These outstanding advantages are offered in 'Surface' One-Way Fired Pits: Simplest Construction; Greater Capacity; Most Efficient Firing; Best Heat Distribution, Lowest Maintenance. *Ask a 'Surface' Sales Engineer for details.*

SURFACE COMBUSTION CORPORATION, TOLEDO 1, OHIO

'Surface' ONE-WAY FIRED SOAKING PITS ◆

KEEP PRODUCTION LINES MOVING



Shear Bars and Shapes *Fast*

with this

BIRDSBORO

Cold Bar Shear

• If you are interested in stepping up production, don't pass by this Birdsboro Cold Bar Shear which has a tremendous capacity for top output at minimum operating and maintenance costs.

This 175 ton, heavy duty, special, open throat shear handles merchant bars and shapes up to 2½" square and other sections of equal area at a rate of 20 cuts per minute.

There is an abundance of power, speed and ruggedness built into this machine which accounts for its dependable, day-after-day operation on the toughest kind of jobs.

The machine shown here has a fully enclosed flywheel powered by a 20 hp. motor with a V-flat drive. All bearings are of high grade bronze except the main pinion bearings which are of anti-friction type. The main gear and pinion are totally enclosed and running in oil. The shear has a hydraulically operated non-knocking clutch and motor operated lubricating system.

This Cold Bar Shear is only one of many types of machines designed and built by Birdsboro. Our engineers will be glad to work with you when you are considering the installation of steel mill equipment.

BIRDSBORO STEEL FOUNDRY and MACHINE COMPANY, BIRDSBORO, PA.

OFFICES IN Birdsboro, Pa and Pittsburgh, Pa.

BIRDSBORO

STEEL MILL EQUIPMENT

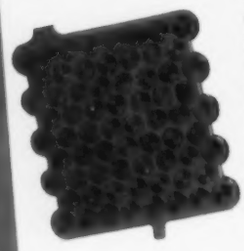
DESIGNERS and BUILDERS of: Steel Mill Equipment • Rolls • Hydraulic Presses • Special Machinery • Crushing Machinery • Steel Castings

EXIDE-IRONCLAD BATTERIES *are DIFFERENT!*

Specially designed to provide dependable power for ELECTRIC INDUSTRIAL TRUCKS

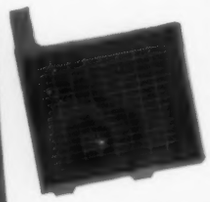
Storage batteries are called upon to perform many tasks. No single type of battery is adequately suited for all. Exide engineers have developed batteries designed to fit each power requirement. They differ in a number of ways, but chiefly in the positive plates around which the other elements are built. In the Exide line there are three basic types of positive plates. The Exide-Ironclad was developed to meet the need for a heavy-duty battery with great reserve power and the ability to discharge at high rates, at high voltage and over a long period of time.

Exide-Ironclad Batteries are DIFFERENT . . . different in design . . . different in construction . . . different in service qualities. Chief among these differences is the unique positive plate, an exclusive Exide feature, which provides advantages not possessed by any other type of plate used in batteries for motive power service. See opposite page for detailed description.



DESIGNED FOR STATIONARY USE

The manchester type of positive plate has the unique lead button construction...rolled strips of corrugated lead, pressed into holes of lead antimony grid. It is widely used by electric utilities, telephone and telegraph companies, radio and television stations... and for railway signal systems, emergency lighting and other stationary applications.



DESIGNED FOR AUTOMOBILE USE

The Exide flat positive plate is of staggered grid construction, pasted with active material which years of experience has proved most efficient and durable for the services for which it was designed. Used for starting, lighting, ignition and other services in cars, trucks, buses, aircraft and general storage battery tasks.

DESIGNED FOR MOTIVE POWER

The Exide-Ironclad positive plate, of slotted tube construction, was developed by Exide Engineers to provide a battery of extra power, sturdiness and durability to meet the exacting needs of motive power equipment. Exide-Ironclad Batteries are noted for high capacity and ability to deliver adequate power throughout each shift. Fully described on opposite page.

1888

DEPENDABLE BATTERIES FOR 61 YEARS

1949

Many Outstanding Features

VENT PLUG
Specially designed to prevent escape of electrolyte.

GREASE SEAL RING NUT
Holds battery elements securely in place . . . prevents creepage of electrolyte . . . keeps tops clean and dry.

SEALED CELL COVER
Flush with top of jar. Prevents collection of dirt or moisture . . . keeps impurities out of cell . . . eliminates leakage of electrolyte.

Consists of a series of finely-slotted tubes which contain the active material. So small are these slots that, while permitting easy access of electrolyte, they retard the active material from readily washing out or jarring loose . . . adding considerably to life of plate.

SEPARATOR
Of high porosity, specially treated to last the life of the battery.

NEGATIVE PLATE
Made extra heavy and built to match the long life of the positive plate.

JAR
Made of specially tough and durable Giant Compound. Built to withstand the jolts and jars of hard industrial usage. Practically unbreakable in normal service.

FEET
Internal short circuits practically eliminated by having the two feet on negative plate rest on different ribs from those of the positive plate, and by having separators extend below both plates and rest on all four ribs.

RIBS
Support all plates and separators. Their height provides generous sediment space, so that internal cleaning is unnecessary.

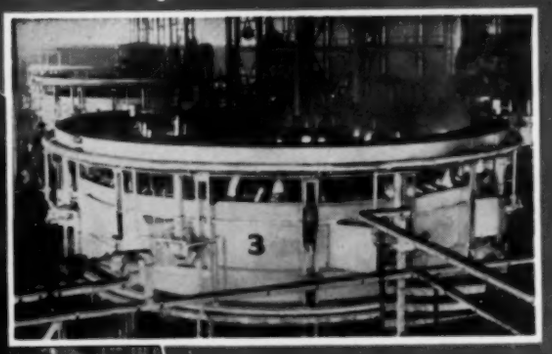
DEPENDABLE POWER

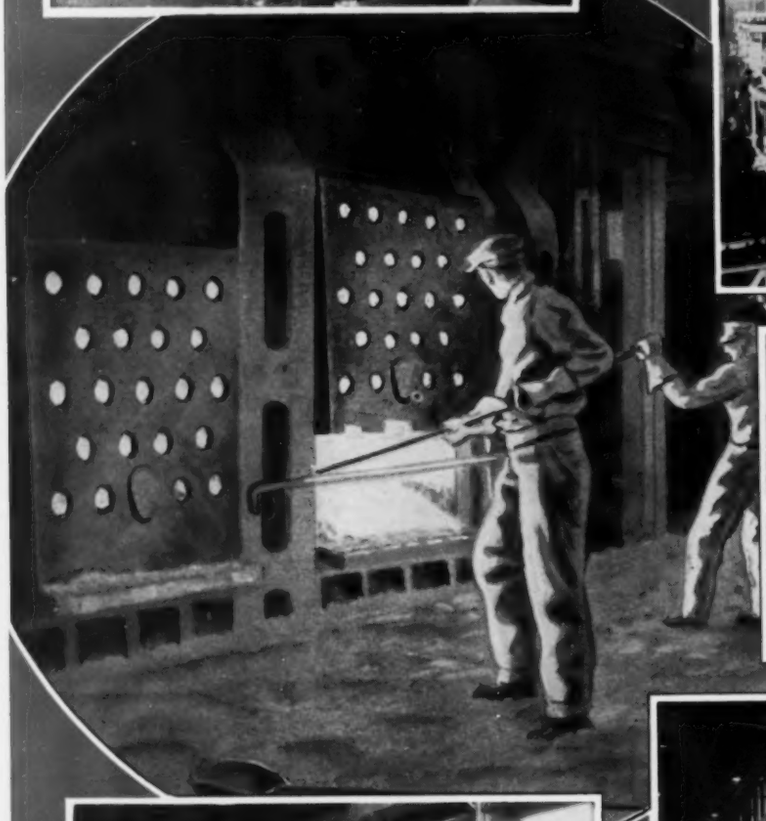
Exide-Ironclad Batteries have ALL FOUR of the characteristics that a storage battery must have to assure maximum performance from battery electric industrial trucks—high power ability, high electrical efficiency, ruggedness and a long life with minimum maintenance. The combination of these four Exide-Ironclad characteristics assures years of dependable day-in, day-out service with economy.

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

"Exide" and "Exide-Ironclad"
Reg. Trade-marks U.S. Pat. Off.

IT'S LOFTUS *all* *Along the Line*





Loftus builds furnaces and complete plants—From Open Hearths right down the line to Heating Furnaces for the final rolling.

Inquiries invited.

610 SMITHFIELD ST **LOFTUS ENGINEERING** *corporation* PITTSBURGH, PA.

Designers and Builders Engineers, Consultants, Contractors

Continental

BAR MILLS

CORRECTLY ENGINEERED FOR TODAY'S REQUIREMENTS

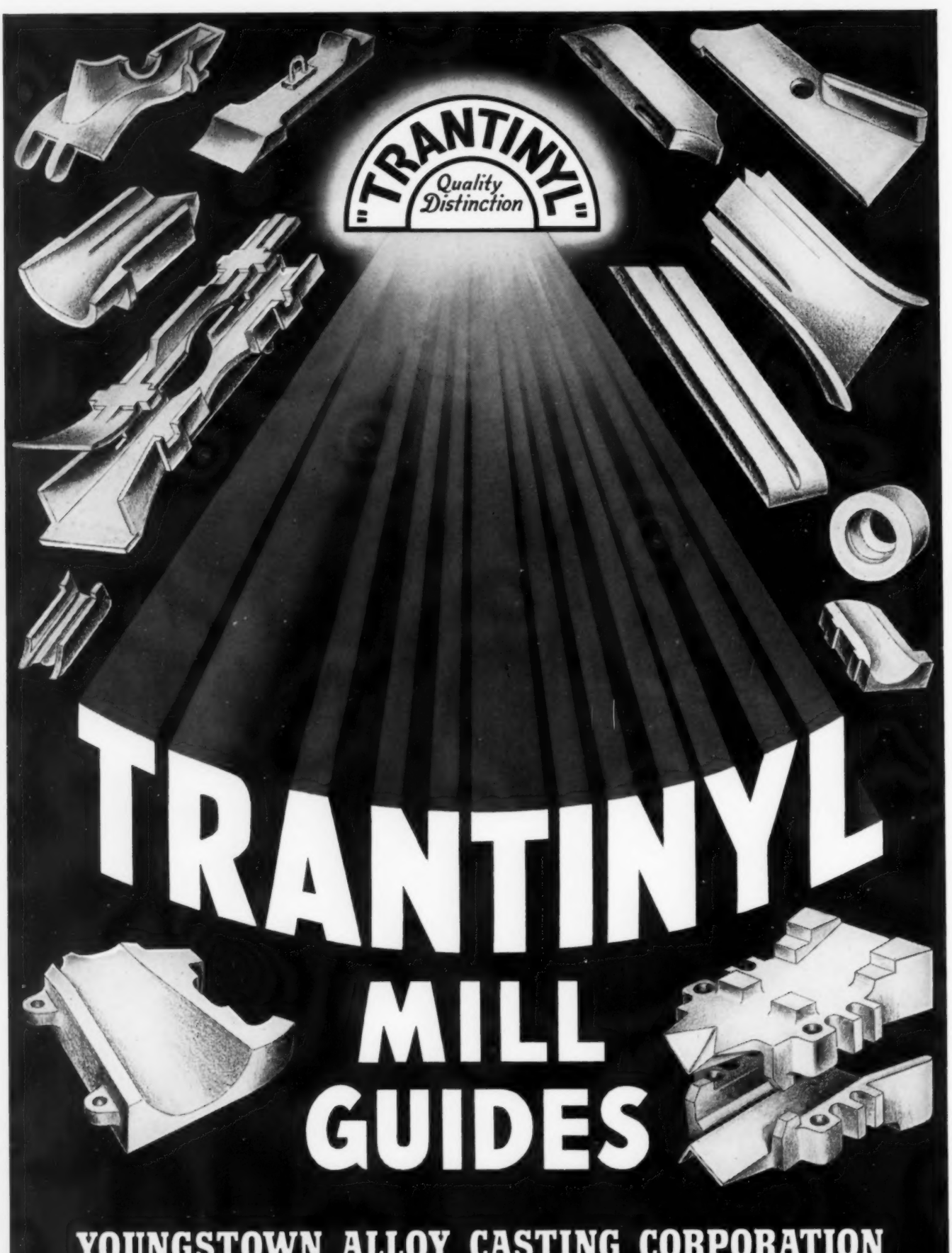
Continental

FOUNDRY & MACHINE CO.

CHICAGO · PITTSBURGH

Plants at: East Chicago, Ind. · Wheeling, W. Va. · Pittsburgh, Pa.

Industry's Headquarters for
Rolling Mills and Equipment
Iron and Steel Rolls
Carbon and Alloy Steel Castings

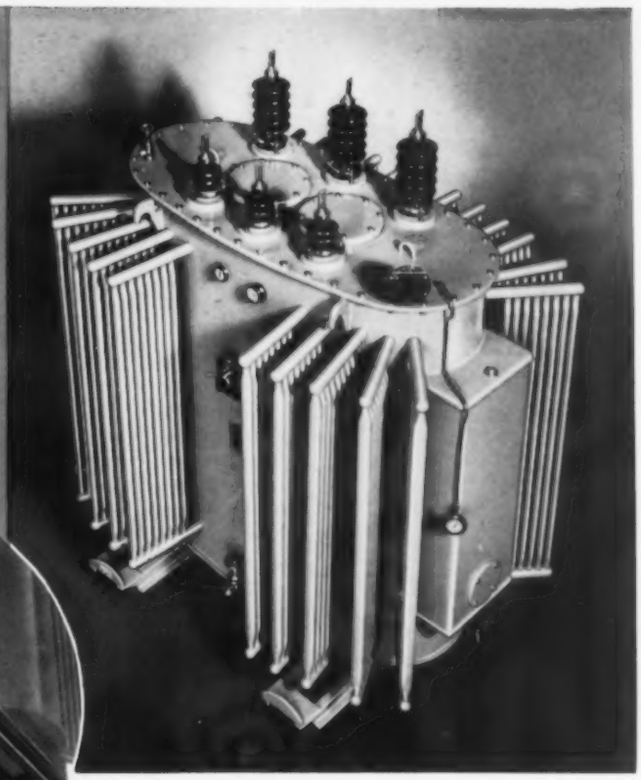

"TRANTINYL"
Quality Distinction
TRANTINYL
MILL
GUIDES
YOUNGSTOWN ALLOY CASTING CORPORATION
Youngstown, Ohio

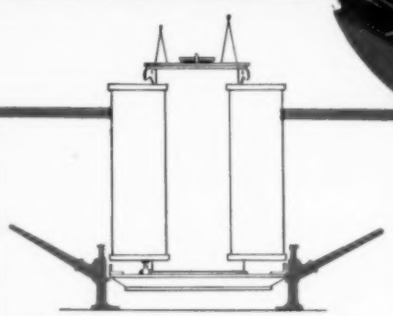
Pennsylvania

STANDARD PARTS POWER TRANSFORMERS

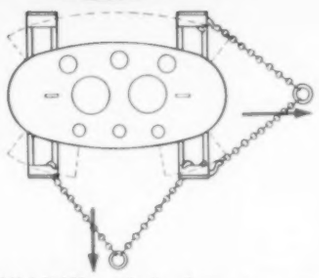
Designed Right... Built Right...

FROM THE BOTTOM UP

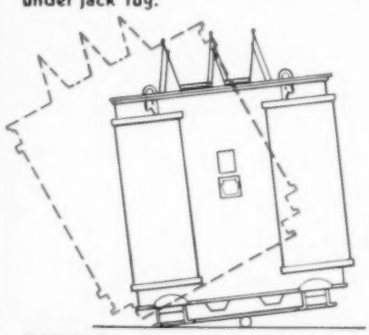




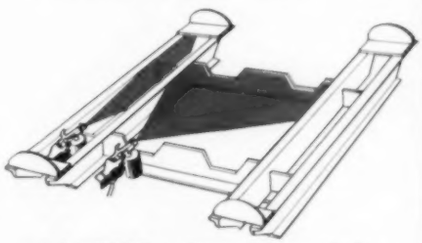
JACKING — Structural steel base members extend to ends of radiators. Radiators offer no interference to jacking. Clearance provided for base of jack to extend under jack lugs. This allows toe of jack to enter all the way under jack lug.



PULLING — Jack lugs are constructed so that a standard hook can be placed in the jack lug to pull the transformer in any direction.



TIPPING — Base design takes into consideration transformer's center of gravity. The largest rolls used cannot tip transformer past its center of gravity.



PAINTING — Ports are provided in base members to ventilate bottom of transformer tank, and to facilitate complete painting of the base and tank bottom. Rust will not attack the tank bottom under these conditions.

Now available in the following sizes:

Three Phase: Up to 10,000 Kva, 34 Kv.
Single Phase: Up to 5,000 Kva, 34 Kv.

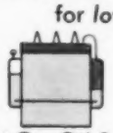
A NEW, IMPROVED structural steel base represents one of the outstanding design features in Pennsylvania's new line of Standard Parts Power Transformers.

This base was designed by Pennsylvania Development Engineers after a thorough study of the requirements of a representative group of transformer users. The sketches illustrate how this new base simplifies jacking, pulling, rolling and painting.

Here is another concrete example of Pennsylvania's Engineering Ingenuity.

You'll discover something new if you write for Booklet No. 1492.

Look to Pennsylvania Standard Parts Power Transformers for *lower prices* and *faster deliveries.*

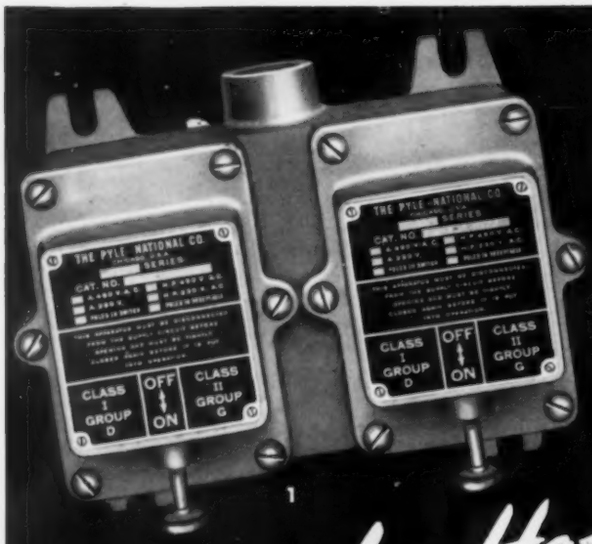


Inert Gas-Oil Seal

Sealed Tank.

Inert Gas Pressure

Pennsylvania
TRANSFORMER COMPANY
PITTSBURGH 12, PENNSYLVANIA



EXPLOSION-PROOF PYLETS ... for Hazardous Locations

EXPLOSION-PROOF SWITCH PYLETS

1. *TUMBLER SWITCHES with push-pull Rod*
to control motors or lighting circuits in hazardous locations. 1 and 2 gang, 1, 2 and 3-pole, 10 to 30 ampere, also 3 way and 4 way, 10 and 20 ampere types.

2. *TUMBLER SWITCHES with interlocking Plug*
Receptacle for use as service outlets for portable electrical equipment in hazardous locations. Plugs cannot be inserted or withdrawn unless switch is open. Switch cannot be closed unless plug is fully inserted. 2 and 3-pole, 20 and 30 ampere, 250 and 460 volt ratings.

3. EXPLOSION-PROOF SECONDARY CIRCUIT BREAKER PYLETS for protection of motors against overloads and stalled rotor currents. Can also be used for "on" and "off" switch. Single and double pole with a selection of interchangeable heater units for protecting fractional horsepower motors.

4. EXPLOSION-PROOF UNIVERSAL JUNCTION PYLETS—6, 7 and 10 hub types with close-up plugs. For easy replacement of sheet metal knockout boxes in the rewiring of old gasoline pump installations.

5. EXPLOSION-PROOF JUNCTION PYLETS available in a wide selection of styles and sizes with threaded or union type hub. Furnished with plain covers for general use or with covers tapped for conduit to support lighting fixtures. Also furnished with pipe plug angle type cover for filling with sealing cement.

6. PYLE-O-FLEX flexible explosion-proof and watertight fittings for adjustable and vibrative connections to motors, floodlights and pendant type lighting fixtures. Furnished in any combination of male and female threaded or female union type end connections with flexible lengths of 4 to 36 inches, conduit sizes ½" to 2" inclusive.

7. EXPLOSION-PROOF SEALING PYLETS have removable pipe plug covers which can be mounted in any one of four positions for filling with cement. Used to isolate the wiring compartments of arc-producing devices from balance of conduit system.

EXPLOSION-PROOF UNIONS, male and female, straight and 90° elbow types.

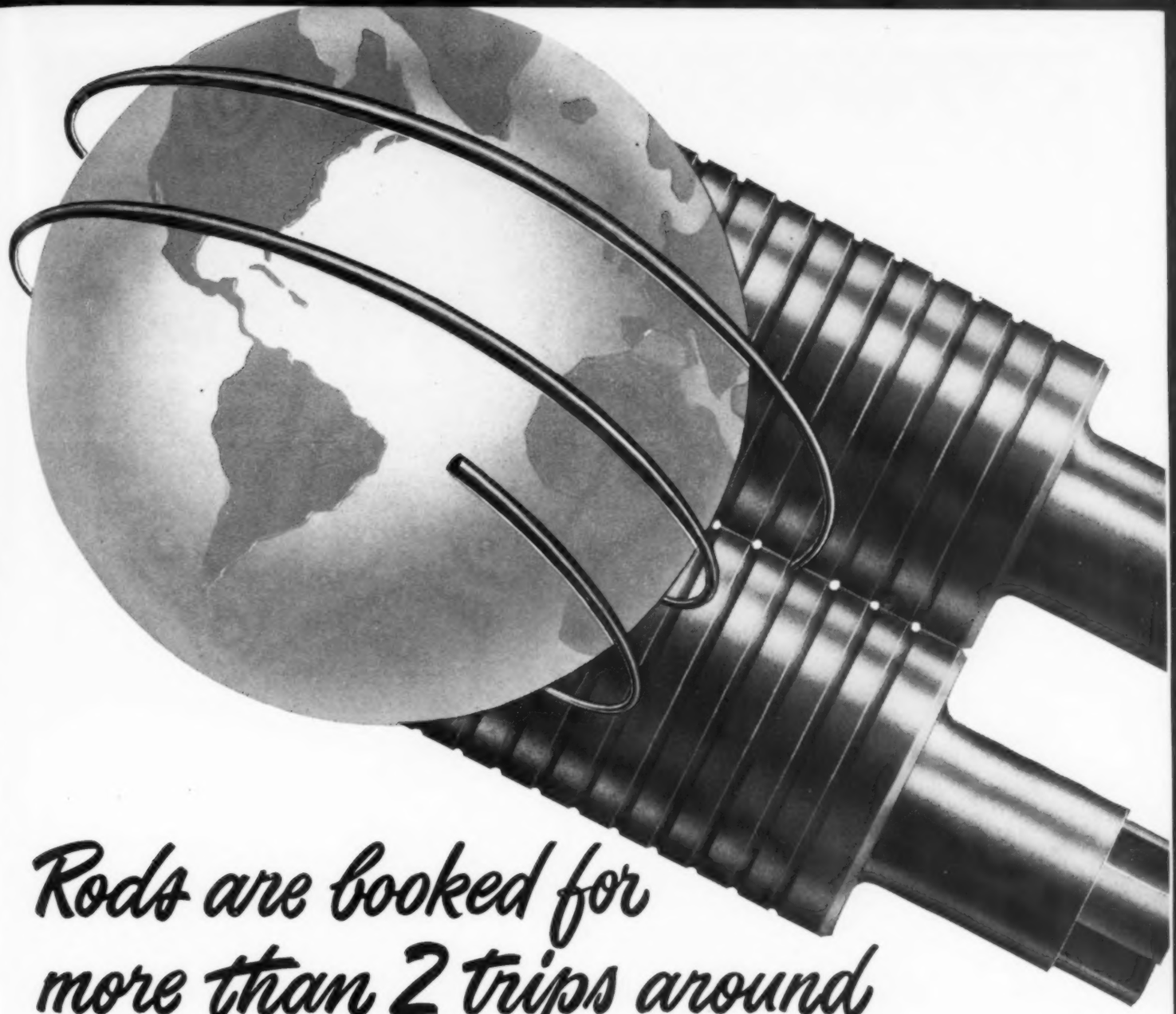
A line of the most commonly used types of conduit fittings for hazardous locations as defined in Article 500 of The National Electrical Code. Explosion-proof Pylets are designed in accordance with Underwriters' Laboratories requirements and are classified in their list of inspected electrical appliances. Their substantial construction and the high quality of materials and workmanship insure safety, uninterrupted service and long life. Consult your Pylet Catalog 1100 for complete listings of the above and other Explosion-Proof and Dust-Tight Pylets.

THE PYLE-NATIONAL COMPANY

1370 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS
DISTRICT OFFICES and REPRESENTATIVES in Principal Cities of the United States
EXPORT DEPARTMENT: International Railway Supply Co., 30 Church St., New York • CANADIAN AGENT: The Holden Co., Ltd., Montreal

SINCE 1897

PLUGS and RECEPTACLES • FLOODLIGHTS • TURBO-GENERATORS • LOCOMOTIVE HEADLIGHTS • MULTI-VENT AIR DISTRIBUTION



Rods are booked for more than 2 trips around the world every day...

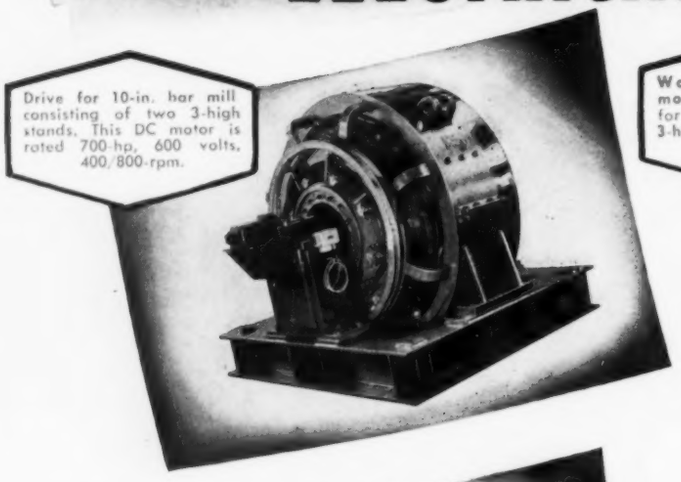
LAST YEAR the rod mills of the United States turned out the equivalent of 14,500,000 miles of No. 5 rods, enough to circle the earth twice each working day . . . a large portion of it on mills using PHOENIX ROLLS.

As a single modern rod mill can produce 850 tons (2,500 miles) of rods per day, the importance of rolls that can maintain this pace becomes apparent. Pittsburgh Rolls can be depended upon to produce the right rolls for all the various types of rod mills . . . rolls that will unfailingly deliver rods at less cost per ton rolled.

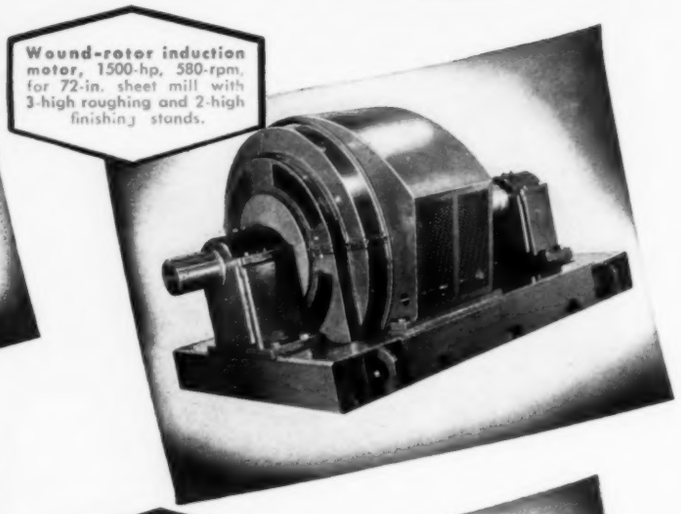
PITTSBURGH ROLLS Division of Blaw-Knox Company
Pittsburgh 1, Pa.

PITTSBURGH ROLLS

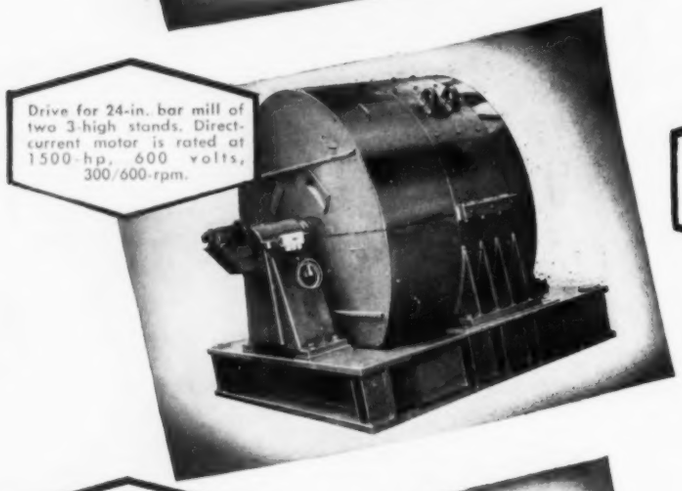
Large Midwest mill selects Elliott FABRI-STEEL ELECTRICAL EQUIPMENT



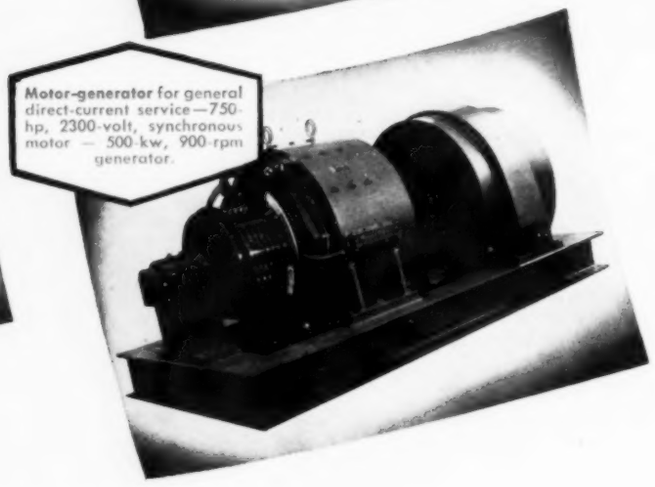
Drive for 10-in. bar mill consisting of two 3-high stands. This DC motor is rated 700-hp, 600 volts, 400/800-rpm.



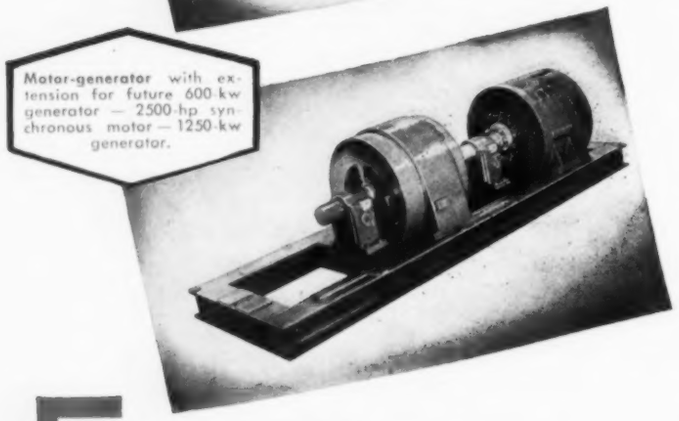
Wound-rotor induction motor, 1500-hp, 580-rpm, for 72-in. sheet mill with 3-high roughing and 2-high finishing stands.



Drive for 24-in. bar mill of two 3-high stands. Direct-current motor is rated at 1500-hp, 600 volts, 300/600-rpm.



Motor-generator for general direct-current service—750-hp, 2300-volt, synchronous motor — 500-kw, 900-rpm generator.



Motor-generator with extension for future 600-kw generator — 2500-hp synchronous motor — 1250-kw generator.

The Elliott equipment furnished to this mill illustrates the wide range of types and sizes of motors and generators that Elliott Company is building for the steel industry. Elliott Company has been building large machines, of both direct-current and alternating-current designs, for 50 years.

Elliott **COMPANY**

Department 15

Ridgway Division, RIDGWAY, PA.

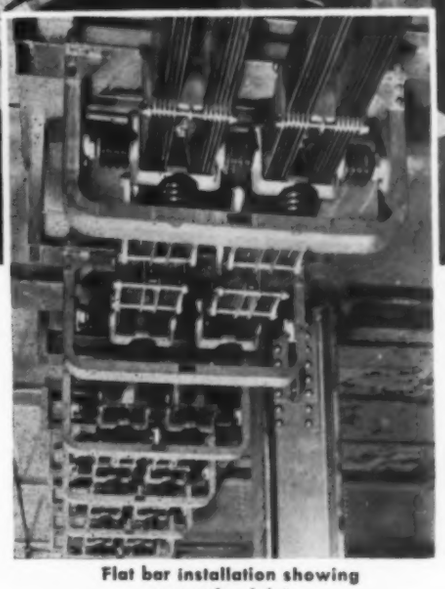
Plants at: JEANNETTE, PA. • RIDGWAY, PA.
SPRINGFIELD, O. • NEWARK, N. J.

DISTRICT OFFICES IN PRINCIPAL CITIES

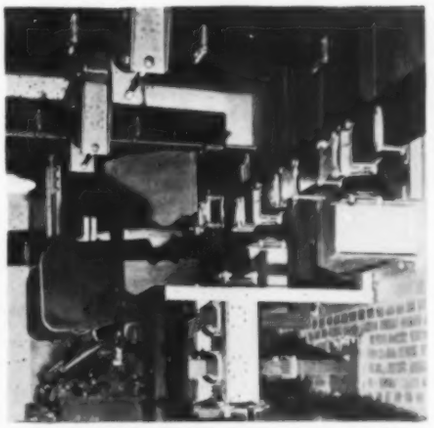
Heavy short circuit stresses will destroy inadequately supported bus structures and disrupt entire electrical installations. You don't risk such a disaster when you install Delta-Star reinforced bus structures engineered to withstand these stresses.

Delta-Star prefabricated reinforced bus structures are designed and furnished complete to the last detail. Heavy steel assemblies, high quality wet process porcelain members used in compression to take advantage of their greatest strength, and careful engineering and fabrication assure a structure you can depend on.

Our engineers will be glad to discuss your bus problems and work out a layout to suit your special requirements. Prefabricated open or enclosed bus structures are available for aluminum or copper bar, tubing, structural and special shapes; indoor or outdoor service.



Flat bar installation showing expansion joint.



Typical arrangement of motor or generator circuit-breaker sections.

OTHER DELTA-STAR PRODUCTS
Used in Mills and Industrial Plants

- Crane Rail Supports
- Disconnecting Switches
- Terminators (Potheads)
- Plugs and Receptacles
- Spool Insulator Cable Supports
- Water Cooled Conductors and Fittings
- Interrupter Switches
- Power Connectors

DELTA-STAR ELECTRIC COMPANY

MAIN OFFICE AND FACTORY — 2400 Block, Fulton St., Chicago 12, Ill.
NEW YORK OFFICE — 140 Cedar St., New York 6, N. Y.

DISTRICT REPRESENTATIVES IN THE FOLLOWING CITIES

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Buffalo, N. Y.
Charlotte, N. C.
Cleveland, Ohio
Dallas, Texas
Denver, Colo.
Detroit, Mich.
Indianapolis, Ind.
Jacksonville, Fla.
Kansas City, Mo.
Knoxville, Tenn.
Los Angeles, Cal.
Minneapolis, Minn.
Norfolk, Neb.
Norfolk, Va.
Philadelphia, Pa.
Pittsburgh, Pa.
Richmond, Va.
Roanoke, Va.
St. Louis, Mo.
San Francisco, Cal.
Seattle, Wash.
Tampa, Fla.
Washington, D. C.
Honolulu, Hawaii

CANADIAN ASSOCIATE

Canadian Line Materials Limited . . . . Toronto 13, Canada

NO. 2 This is the second advertisement describing value of Allis-Chalmers equipment in ore beneficiation.

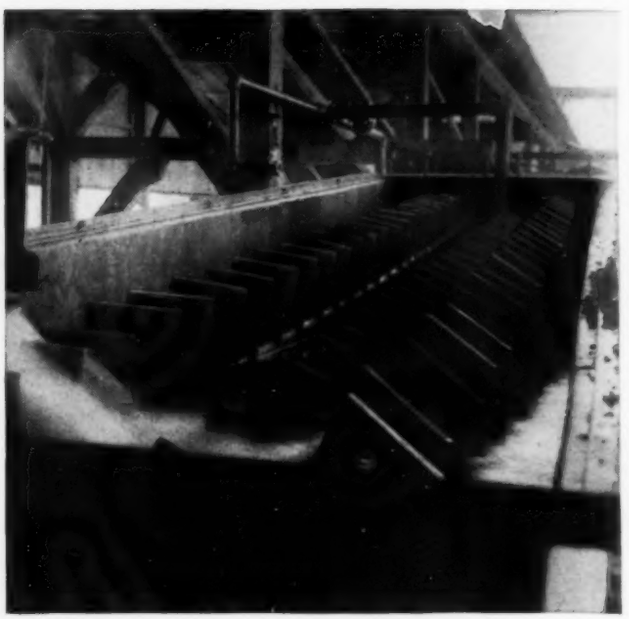
ALLIS-CHALMERS

Low Grade

With Steel Mills Operating at 100% Capacity, Iron Ore Producers are Looking to Beneficiation of Low Grades To Beat Shrinking Ore Supplies. Allis-Chalmers, One of The World's Largest Manufacturers of Ore Reduction Machinery, Furnishes Basic and Auxiliary Equipment for Ore Concentration Plants.

MANY OF THE IRON ORE PREPARATION plants already in operation use Allis-Chalmers equipment to increase production. As three tons of low-grade ores have to be processed to produce one ton of concentrate, producers must step up the scale of mining to make low grades pay off. And that's where Allis-Chalmers can help.

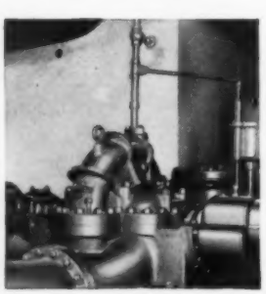
Specialized Allis-Chalmers engineers have studied ore beneficiation methods and equipment from a cost-cutting, tonnage increasing point of view. These specialists guide in the selection of your equipment and help develop new, improved processing equipment.



ALL BASIC TYPES OF WASHING EQUIPMENT are built by Allis-Chalmers. The improved log washer shown above is applied to ores, aggregates and other materials for removal of medium sticky clays. The log washer takes up to three inch feed size. One base for both washer and drive saves materially on installation, power needed and maintenance.

Blade mills handling up to 12 inch feeds are used in beneficiation plants. Other A-C washers are revolving scrubbers, screw washers, rotary scrubber, screens and vibrating screens coupled with water pipes and jets.

Allis - Chalmers ▶ centrifugal pumps are supplied with capacities from 30 to over 170,000 gpm, heads to 475 ft. Back of every pump is 50 years of A-C pump design and manufacturing experience.



Weatherproofed ▶ for rough outdoor use, Allis-Chalmers motors furnish all the electrical and mechanical characteristics desired for processing. Sizes range from one hp for both a-c and d-c service.

Teamwork of ▶ Allis - Chalmers equipment is illustrated here. Texrope drives are used with A-C motors for primary and secondary crushers in ore beneficiation plants around the world.

Power, Electrical, Processing Equipment for Iron and Steel

ALLIS-

BUILDS EQUIPMENT TO MAKE
Ores Pay Off

ALLIS-CHALMERS HAS PIONEERED in development of three types of screens for the ore industry. Heavy duty Style C screens, shown above, handle peak loads of 1000 tph for scalping between feeders and large jaw crushers. They are designed to handle maximum sizes of 4" diameter.

Ripl-Flo screens, designed for medium and heavy duty, have wide application in screening ahead of the secondary crushers. This inclined screen features a two bearing eccentric shaft permitting reduced screen width and height and low installation cost. They are available with one, two or three decks.

Low Head screens with specially designed decks are used for primary screening ahead of heavy density units. They drain media adhering to tails and concentrates.

IT IS IMPORTANT that you consider future processing equipment needs NOW. An Allis-Chalmers representative will be glad to tell you more about the complete line of ore beneficiation equipment. Call your district Allis-Chalmers office or write direct.

Allis-Chalmers builds single and multi-circuit unit substations for outdoor service. Because of their compactness and ease of maintenance, they can be installed practically anywhere.

Low-Head, Ripl-Flo and Texrope are Allis-Chalmers Trademarks.

ALLIS-CHALMERS

ALLIS-CHALMERS BUILDS EQUIPM

Low Grade Ores F

Send coupon below for reprints of advertisements describing Allis-Chalmers equipment for ore beneficiation.

ALLIS-CHALMERS, 1020A SO. 70 ST.
MILWAUKEE, WIS.

Please send advertisement reprints on Allis-Chalmers ore beneficiation equipment.

Name

Title

Company

Address A 2606

Savings here–

Start here!

A-B-K roller neck bearing with separate collar.

A-B-K Laminated Plastic Bearings Wear Longer–Cost Less to Maintain

Are excessive bearing maintenance and replacement costs eating into your profit-per-ton? Chances are it will pay you to check—and to replace conventional bearings with modern A-B-K Laminated Plastic Bearings.

In a wide range of mill applications, A-B-K bearings actually *outwear metal*. They are exceptionally slow-wearing and heat resistant . . . will not distort under shock. And because A-B-K material holds gauge longer, fewer oversizes and fewer adjustments are required . . . In addition, A-B-K Laminated Plastic Bearings are successfully lubricated with *water*. You *save* the cost of oil or grease. Power consumption is reduced, too, because of A-B-K's low co-efficient of friction.

Consider these advantages for specific applications in your mill. A letter, phone call or wire will bring an experienced A-B-K representative to your office. He will place our engineering and production facilities at your disposal.

A-B-K slipper bearing, with patented reinforced edge. (At Right: phantom view)

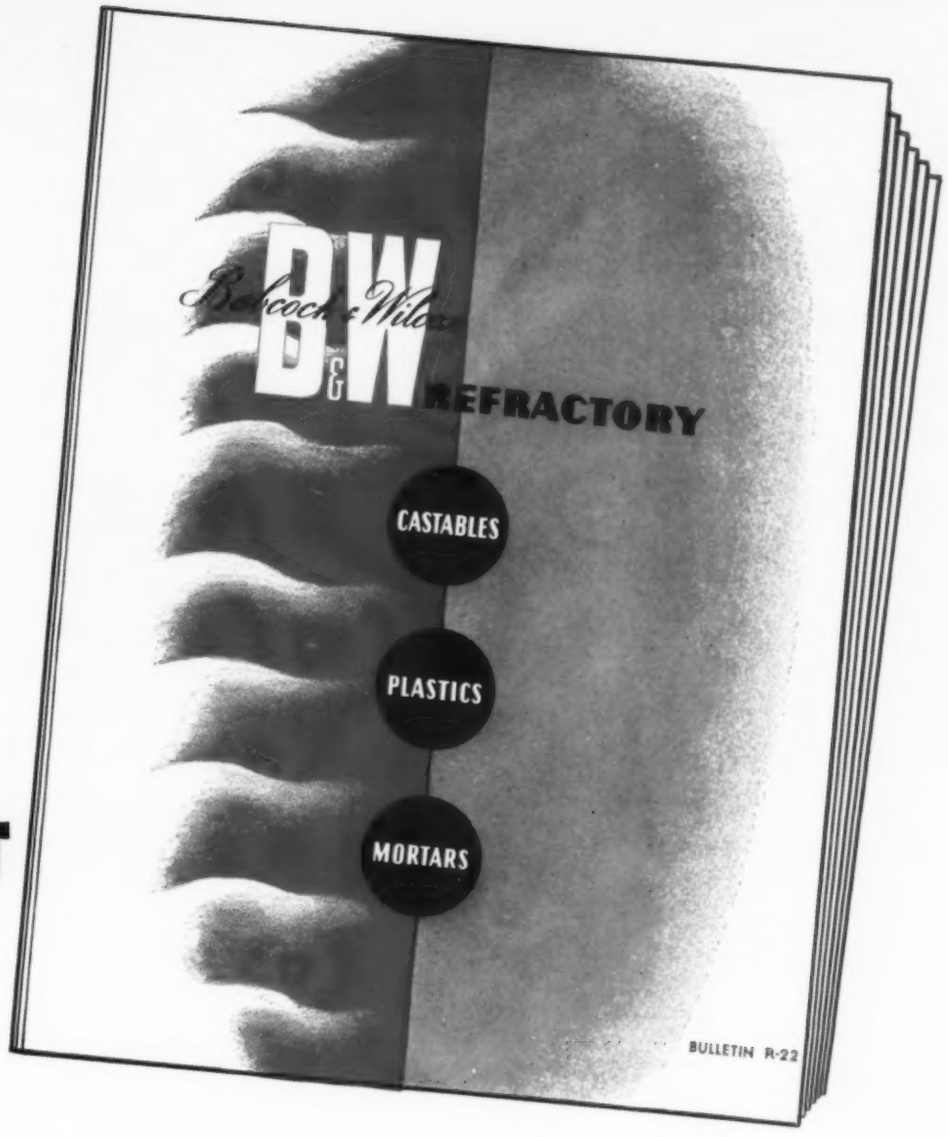
A·B·K
Laminated Plastic Bearings

AMERICAN Brake Shoe COMPANY

AMERICAN BRAKEBLOK DIVISION
DETROIT 9, MICHIGAN

What to use... Where to use it!

NEW B&W BOOKLET



Here, for the first time, is a handy reference booklet summarizing significant data and application information for a wide range of important refractory materials:

. . . A complete section on Refractory Castables, including the new outstanding B&W high temperature materials that are establishing new standards in furnace construction and maintenance.

. . . Data on Refractory Plastics . . . what they are, their properties, when to use them.

. . . A thorough review of Refractory Mortars, together with convenient tables for selecting and determining quantities.

Furnace designers and builders looking for ways to reduce first cost . . . furnace owners and operators seeking longer furnace life, less maintenance, increased output . . . will all want this convenient bulletin. Your copy of Bulletin R-22 is waiting for you . . . write for it today.

R-346

B&W REFRACTORIES PRODUCTS

B&W 80 FIREBRICK • B&W JUNIOR FIREBRICK
B&W 80 GLASS TANK BLOCKS • B&W INSULATING FIREBRICK
B&W REFRACTORY CASTABLES, PLASTICS AND MORTARS

•

OTHER B&W PRODUCTS

Stationary & Marine Boilers and Component Equipment
Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers
Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: AUGUSTA, GA.

While ordinary cranes may be adequate for the average job, steel mill engineers know that nothing but the finest obtainable is good enough for hard steel mill service.

For 50 years Cleveland has specialized in quality cranes. They have fully proven themselves and are held in esteem throughout the steel industry.

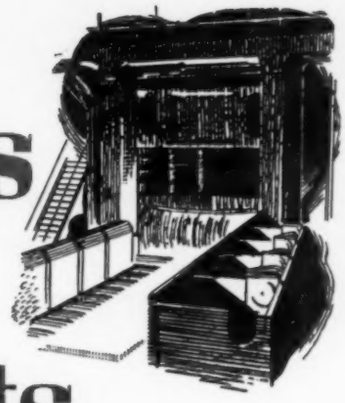
THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts



IRON ore production for 1948 in the United States totaled 101,350,000 gross tons. Of this, 82 per cent came from the lake region, 8 per cent from southeastern states, 4.4 per cent from northeastern states, 5 per cent from western states, and 0.6 per cent from miscellaneous sources. In addition, 6,086,070 gross tons of iron ore were imported, principally from Chile, Sweden and Canada, but with small quantities from 14 other countries.

▲

ACCORDING to Charles E. Wilson, president of General Electric Co.: "The much discussed relation of profit to investment is an extremely fictitious and unrealistic standard. This is so because it tends to measure today's profits on the basis of yesterday's investment dollar. To do this would ignore the fact that the replacement cost of our plant at today's prices is estimated to be more than $300,000,000 in excess of the actual cost."

▲

THE person that defined a conference as a discussion whose object is to defer a decision must be the same guy that thinks the best committee consists of three individuals, one of whom is sick and another absent.

▲

NO doubt our readers have noticed, just as we have, the tremendous increase in solicitations for funds for various causes. There is never a day passes without some request, either by mail, telephone, radio or personal contact. Most of these are for worthy causes, and we certainly do not want to disparage or discredit those. But their mushroom growth in recent years is puzzling. Is it just that money is plentiful, and every agency is climbing on the gravy train? Or is it that many of these agencies used to depend on a few large contributions from wealthy donors, sources which present economic conditions have dried up?

Under the prevailing system of general solicitation, there is probably not an equitable apportioning of funds between agencies. The cause that appeals most to public sympathy — or perhaps the one that has the best publicity staff — is apt to garner the lion's share, regardless of actual needs. In fact, some agencies are now being criticized for collecting more than they need. There was a time when it was thought best to consolidate all civic or district fund raising activities into one concerted drive, but we seem to have a totally new flock — and more than ever.

JUST to prove there's nothing new in the world, the Journal of Education advises that, in the language of the Zapotec Indians, the word for man is the same as the word for wolf.

▲

BRITISH steel prices have been raised about nine per cent to allow the government to drop $100,000,000 per year of its subsidy on high-priced imported raw materials. In the future, the steel industry will meet most of the cost of imported scrap, ore and pig iron out of its own revenues. This move, in the face of nationalization of the industry, shows the realistic attitude of the British. The United States government could use a little realism in its use of subsidies.

▲

IF anyone is inclined to wonder why John L. Lewis holds the blind loyalty of the coal miners, let him reflect upon these figures, issued by the Bituminous Coal Institute: Coal miners in 1948 received three times as much in wages as in 1939. The industry payroll totaled more than $1,500,000,000, with the hourly rate averaging $1.95 as compared with 89 cents in 1939.

▲

ONE of our correspondents says that a family tree is a device for tracing yourself back to better people than you are.

▲

ACCORDING to the Travelers Insurance Companies, traffic deaths in 1948 totaled 32,200, about one per cent under the 1947 figure. Traffic injuries, however, mounted to an all-time peak of 1,471,000, eight per cent above 1947. In other words, about one out of every 100 people in the United States was hurt in traffic accidents. It's too bad that the fine safety record set by industry can't be carried over into our driving habits.

▲

AND incidentally, motor vehicle accidents involving youthful drivers are steadily increasing out of all proportion to the number of such drivers — just adding to our perplexity as to why children are too young to work under 18 years of age, but are old enough to drive a ton-and-a-half car at 60 or 70 miles an hour.

▲

CURRENT contractors' bids for various construction projects are running as much as 15 per cent below estimates. This is said to be due to elimination of much of the allowance formerly included to protect against increases in prices.

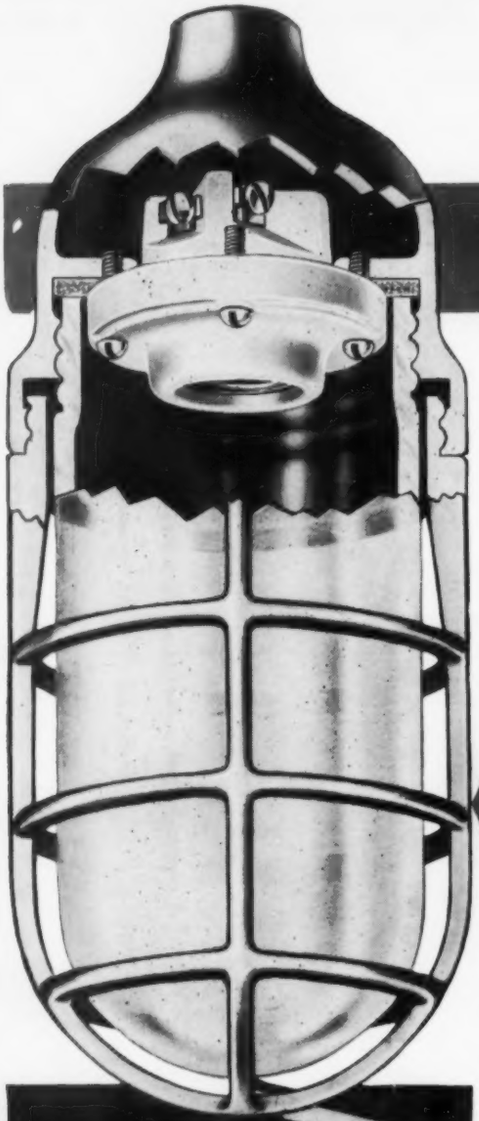
▲

A DISILLUSIONED soul says that, if a new Statue of Liberty is ever designed, it will be holding the bag instead of the torch.

▲

FINAL approval from the Federal Power Commission has cleared the way for a new 26 in. natural gas pipe line extending over 800 miles from the fields of Texas and Louisiana, through the Mississippi and Ohio River valleys to a connection with the Big Inch pipe line near Middletown, Ohio. Completion of this project, which will cost $73,500,000, will add approximately 400,000,000 cu ft of gas per day to the present pipe line capacity. This will mean greater gas supplies for consumers as far north and east as Syracuse, New York.

Vaportight
Industrial Lighting
CONDULET*



For use in boiler rooms, powerhouses, shower rooms, tunnels, loading docks, building entrances, and all indoor and outdoor locations where exposed to moisture and rain, non-explosive vapors and gases, or non-combustible dusts.

Vaportight and raintight.

Wiring chamber remains vaportight even though globe is off.

Porcelain Receptacle.

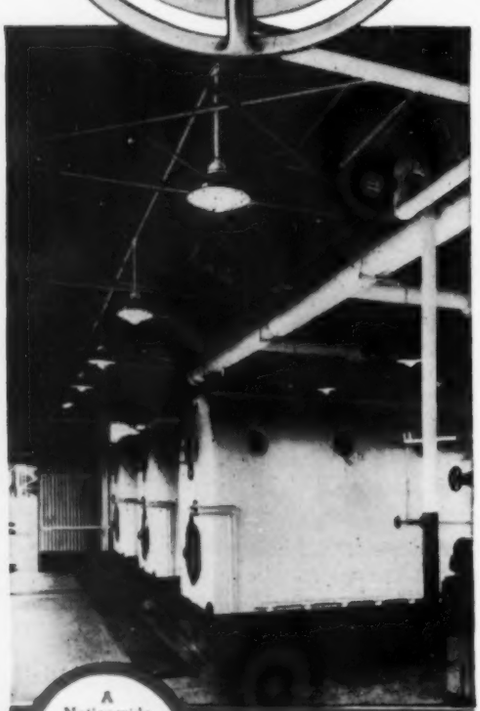
Screw guard or clamp guard.

11 Hub arrangements.

4 Reflector styles.

Accessories: Colored globes, pear-shaped globes and guards, half shades, and adapters.

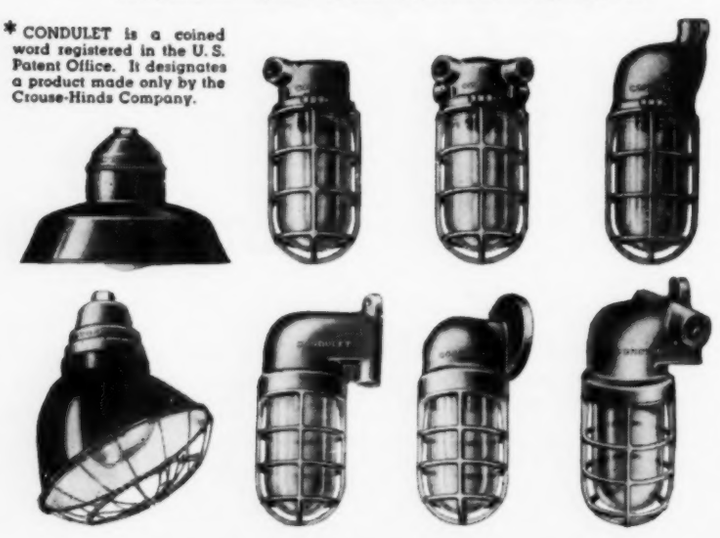
4 Sizes: 50 through 500-Watt.



Vaportight lighting fixtures are available for attaching to several round-base Condulets and sheet steel outlet boxes. Crouse-Hinds complete *Vaportight* line includes hand lamps, switches, plug receptacles, and other electrical devices.

Complete listings in Section 25, Condulet Catalog 2500.

* CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.



A Nationwide Distribution Through Electrical Wholesalers

CONDULETS
FLOODLIGHTS
TRAFFIC SIGNALS
AIRPORT LIGHTING

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

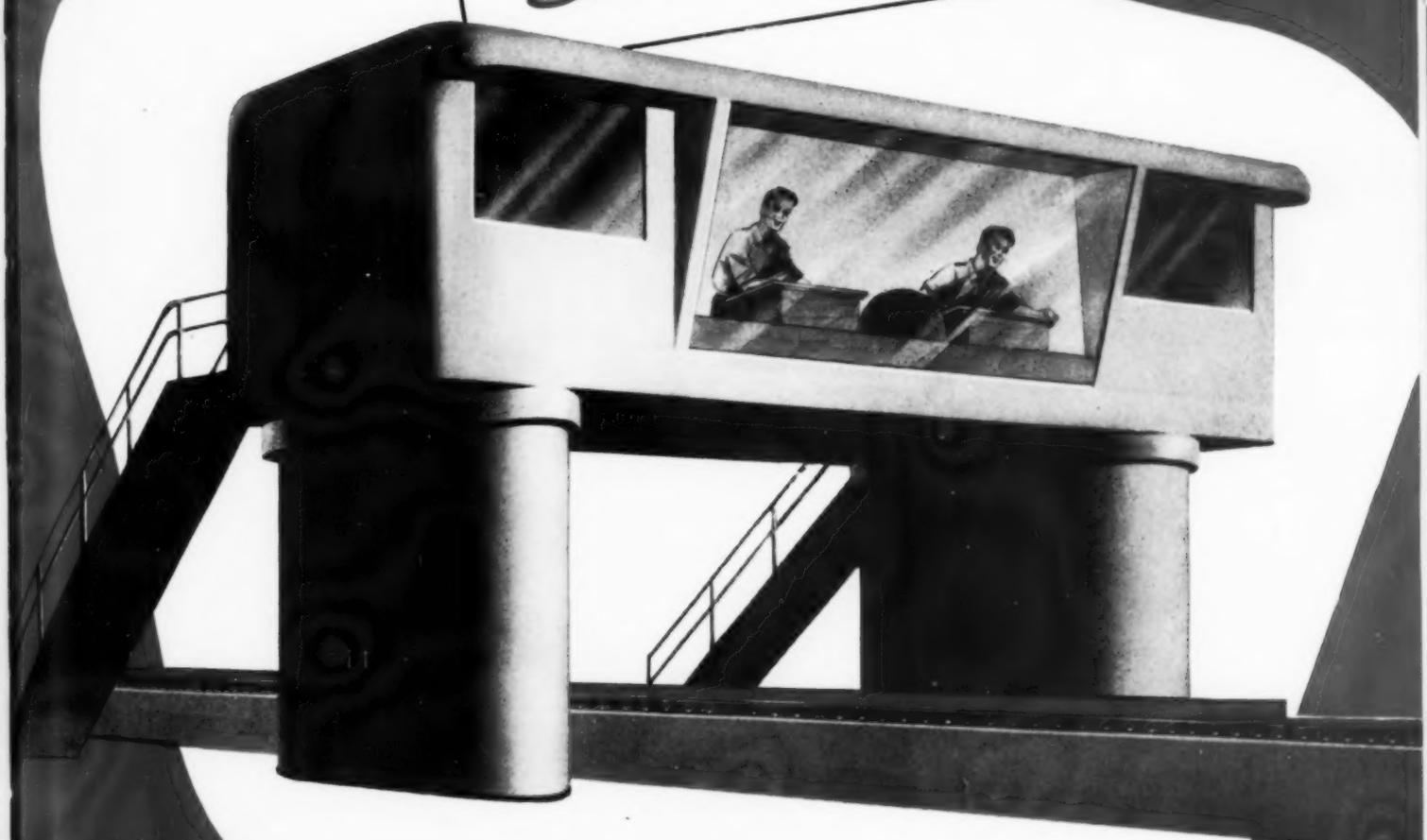
Offices: Birmingham – Boston – Buffalo – Chicago – Cincinnati – Cleveland – Dallas – Denver – Detroit Houston – Indianapolis – Kansas City – Los Angeles – Milwaukee – Minneapolis – New York Philadelphia – Pittsburgh – Portland, Ore. – San Francisco – Seattle – St. Louis – Washington.
Resident Representatives: Albany – Atlanta – Charlotte – New Orleans – Richmond, Va.
CROUSE-HINDS COMPANY OF CANADA, LTD., *Main Office and Plant:* TORONTO, ONT.

Modern Streamlined

MILL OPERATORS' PULPITS

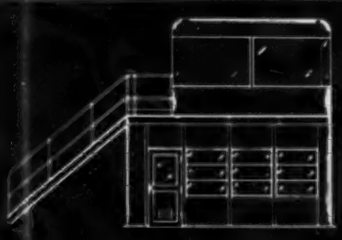
AND PORTABLE MILL OFFICES

BY *Lee Wilson*



DESIGNED, FABRICATED AND ERECTED

BY

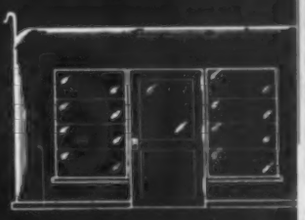


Combination Pulpit and Mill office — Air Conditioned if desired

Lee Wilson **CONSTRUCTION COMPANY**

Subsidiary of LEE WILSON ENGINEERING CO., Inc.

20005 WEST LAKE ROAD ★ CLEVELAND, OHIO ★ TEL. ACADEMY 4670



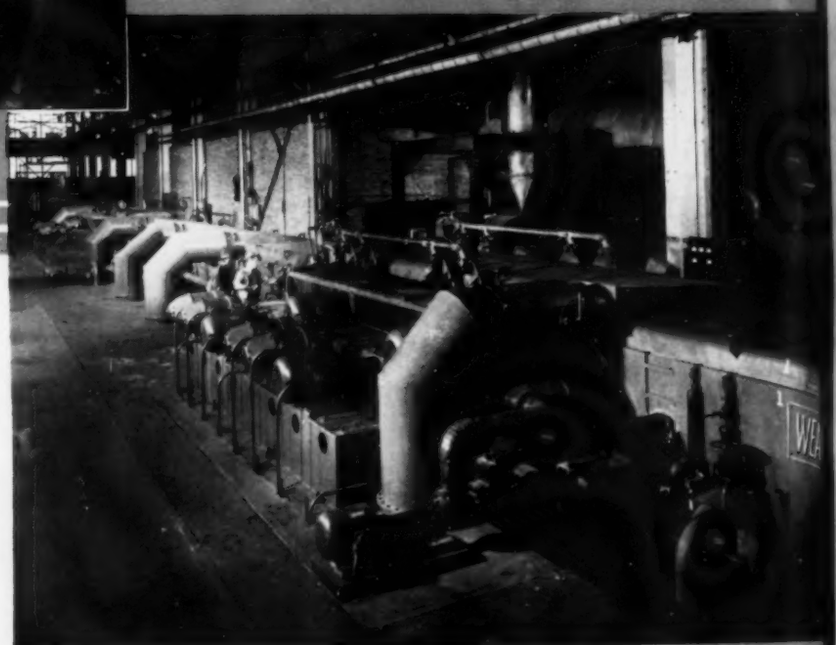
Portable Mill offices

ENTRY END

The WEAN ENGINEERING Company, Inc.

WARREN, OHIO

CLEANING SECTION



EXIT END

THE Wean "anodic cathodic" high speed electrolytic strip cleaning line represents the most advanced development in continuous strip cleaning. This line meets the most exacting requirements for subsequent coating operations.

SPECIALISTS IN SHEET, TIN & STRIP MILL EQUIPMENT

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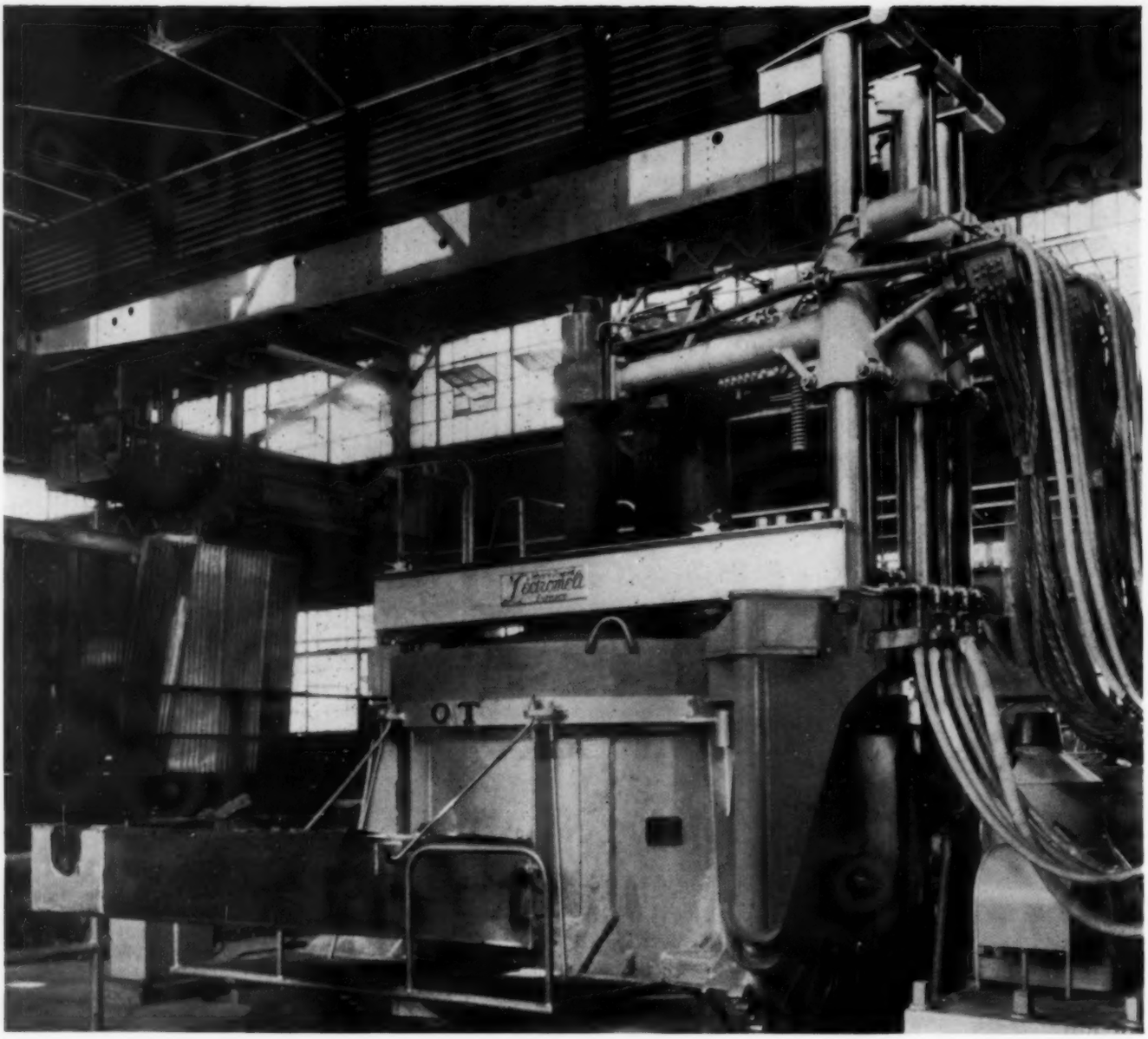

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Fuel Oil in the Steel Industry

. . . . as supplies of high grade fuels diminish, the ingenuity of the engineer will find economical methods to make use of or adapt those which are available . . . .

By A. J. FISHER
Assistant Chief Engineer of Construction
Bethlehem Steel Co.
Bethlehem, Pa.

▲ AS the galaxies go, so go the stars, and the sun, and the sun's third planet with its attendant biology; and complex within the biology, of course, is man. Much has been said about the features of man that set him apart from the other animals of the earth. It is true that he makes conversation and exchanges ideas, but basically he alone makes and works with tools. Of the many tools that he uses, controlled fire is the greatest and most valuable of all—for without fire man would still be swinging a wooden club for self protection and self preservation—nothing more, nothing less.

Today, our civilization and economy is so interwoven with fire that organized society would completely collapse in a very short time without it. We have had some demonstrations recently on trying to do without coal; and many of us were amazed how quickly our industry slowed down. But that was only one fuel. Can you imagine what would happen if both coal and petroleum products were taken away from us at the same time? Yet in time this very same serious problem must be faced by the human race when the biological remains of the abundant plant and animal life, generated and stored in the earth millions of years ago, are used up and gone. Consider this with the dying sun and the ever widening orbit of the earth and you will have a faint idea of the tremendous fuel problems that must ultimately be faced by man. So, let us use our now present fuel heritage with reverence and caution that we may not be severely criticized by the generations to come.

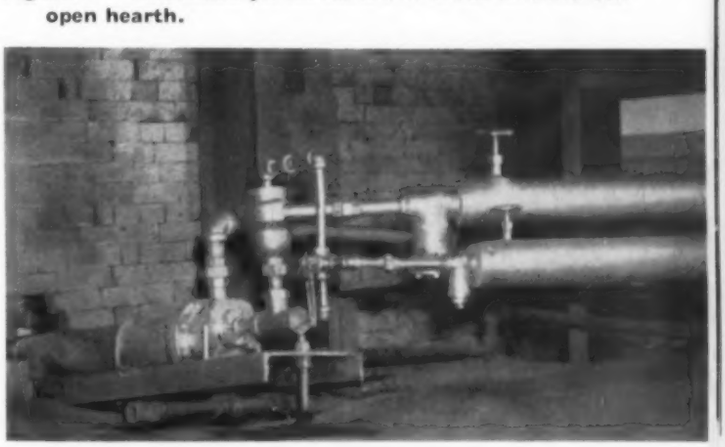
Early American steelmaking was based on coal, either by means of burning the coal directly on stokers, in powdered form, or in gas producers. This condition existed up until about 1905 when fairly large quantities of fuel oil were introduced into the open hearth furnace operation away from the districts where natural gas was available. Because of the increase in thermal efficiency and steel production with oil as a fuel, it was easy to economically replace the bituminous gas producers used in most open hearth furnace plants. However during World War I, many open hearth plants were quickly changed to fuel oil for the primary purpose of increasing steel production alone. The use of oil in the steel industry for purposes other than open hearth operation has always been based on its availability and its relation in cost to coal at the point of consumption. Consequently, the areas near the coal mines remained with coal, while the areas near to the oil fields, on or near tidewater, where fuel oil transportation was cheap, changed from coal to oil.

Before going into detail with respect to the steel industry, I should like to present some tabulations and other facts on the general state of fuel reserves and fuel consumption in America, then go back to the historic origins of fire and fuel, also touching briefly on the evolution of fuel consumption. By starting with these considerations we may see the fuel situation in the steel industry in its relationship to the total picture.

Table I gives the estimated mineral fuel reserves of the United States of America. From the figures in this tabulation it is easy to see that water power, heat pumps, oil shale, and atomic energy will soon be relied upon in expanding quantities to replace our present natural fuels.

The world output of crude oil has almost doubled since 1929. This is shown in Table II. The continued demand for fuel oil is staggering. Nobody wants to burn coal if they can get and afford oil. Oil is easily stored, handled, and controlled. Being practically free from

Figure 1 — This multi-jet oil burner is in use on a 215-ton open hearth.



Presented before AISE Annual Convention, Cleveland, Ohio, September 28, 1948 and the Joint Conference of the Institute of Fuel and the Institute of Petroleum, Birmingham, England, September 21, 1948

TABLE I

Estimated Mineral — Fuel Reserves of the USA

	Reserve Jan. 1 1947	Per cent of total fuel reserves (13,000 Btu per lb basis) (a)	Assumed annual production	Reserve divided by annual production plus loss (b)
Anthracite (Billions of net tons)	15	0.7	0.059	165
Low volatile bituminous (Billions of net tons) (c)	56	2.2	0.124	317
High volatile bituminous (Billions of net tons) (c)	1403	64.4	0.485	2024
Sub-bituminous (Billions of net tons)	598	19.3	0.010	.....
Lignite (Billions of net tons)	484	11.0	0.002	.....
Total coals	2556	97.6	0.680	2595
Petroleum (Billions of barrels) (d)	21.5	0.2	1.85	11.6
Oil from oil shale (Billions of barrels)	200(f)	2.0	1.85(e)	100.8
Natural gas (Trillions of cu ft) (d)	5.2	0.2	0.154	34.0
Total, all fuels	2587	100.0	1.226	1700

(a) Heating values used in conversion:

Anthracite	12,700 Btu per lb
Low volatile bituminous	14,000 Btu per lb
High volatile bituminous	13,500 Btu per lb
Sub-bituminous	9,500 Btu per lb
Lignite	6,700 Btu per lb
Petroleum	6,000,000 Btu per bbl
Natural gas	1,000 Btu per cu ft

(b) Recovery of 65 per cent is assumed for anthracite and 70 per cent for all other coals and lignite.
(c) Includes some medium volatile coal.
(d) Proved reserves only.
(e) Not included in the total.
(f) Colorado and Wyoming only.

TABLE II

World Crude Oil Production
(M. Barrels of 42 U.S. Gallons)

Year	USA	South America	Balance of western hemisphere	Eastern hemisphere	Total world
1929	1,007,323	182,051	54,521	241,972	1,485,867
1930	898,011	180,075	50,471	283,347	1,411,904
1931	851,081	158,435	44,326	319,814	1,373,656
1932	785,159	157,624	43,975	323,540	1,310,298
1933	905,656	159,558	44,707	331,086	1,441,007
1934	908,065	185,579	50,477	377,353	1,521,474
1935	996,596	199,112	53,359	405,421	1,654,488
1936	1,099,687	208,648	55,765	427,440	1,791,540
1937	1,279,160	242,924	65,387	451,760	2,039,231
1938	1,214,355	245,143	63,287	465,256	1,988,041
1939	1,264,962	264,976	70,118	486,104	2,086,160
1940	1,353,214	246,537	74,996	475,074	2,149,821
1941	1,402,228	288,586	72,986	456,857	2,220,657
1942	1,386,645	198,114	67,399	440,925	2,093,083
1943	1,505,613	235,957	66,750	448,332	2,256,652
1944	1,677,904	321,292	70,591	521,167	2,590,954
1945	1,713,655	385,355	73,273	422,124	2,594,407
1946	1,733,939	446,417	77,286	492,548	2,750,190
1947	1,856,107	.....	.....	.....	.....

ash, there is no disposal problem after burning. It is a preferred fuel.

The refinery input-output for the past six years for the United States of America is shown in Table III. The increasing demand for all refinery products, especially during the post war years, is quite apparent.

The detailed distribution of the consumption of refinery oil products in the United States of America for the last six years is shown in Table IV. Under the heading of "Residual Fuel Oil," it will be noted that the oil consumption of the steel industry has remained about stationary for the past six years, slightly increasing to 51,677,000 barrels for the year 1947. This is the fuel oil item about which this paper is chiefly concerned, namely, "Residual Fuel Oil in the Steel Industry of the U.S.A." Although our industry is large and requires considerable quantities of fuel, it is surprising to know that for 1947 it burned about 9.8 per cent of the total residual fuel oil consumed in the United States, which is only 2.8 per cent of the crude oil input to the stills.

From Table IV, it is readily seen that the uses of gasoline, kerosene and distillate fuel oils are increasing at a higher rate than residual fuel oil and that these

Figure 2 — The recuperative pit shown here can be fired with either gas or oil or both in combination.

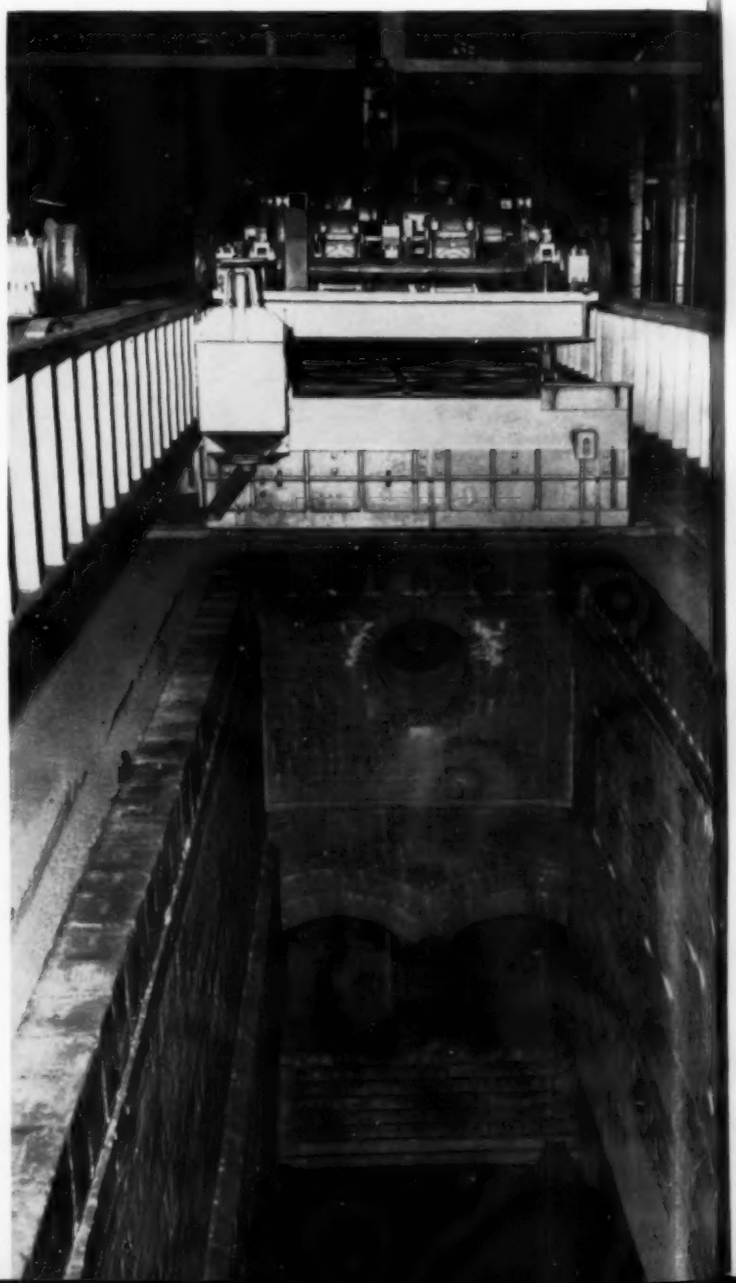


TABLE III

Refinery Input — Output — United States of America
(M. Barrels at 42 U. S. Gallons)

	1942	1943	1944	1945	1946	1947
Refinery input						
Crude run to stills	1,334,103	1,429,738	1,665,684	1,719,534	1,730,197	1,852,246
Unfinished oils re-run (net)	3,353	—2,597	—2,584	5,727	1,615	1,227
	1,337,456	1,427,141	1,663,100	1,725,261	1,731,812	1,853,473
Production from crude oil and oil re-run						
Gasoline	532,045	532,236	657,256	699,244	685,442	745,133
Kerosene	67,474	72,270	78,344	81,024	104,385	110,412
Gas oil and distillate fuel oil	196,714	211,516	239,152	249,224	287,896	312,173
Residual fuel oil	358,901	417,306	461,455	469,492	431,364	447,795
Lubricants	38,626	38,679	41,106	41,867	45,645	51,765
Other oils	138,905	145,511	172,610	177,456	175,385	181,793
Loss	4,791	9,623	13,177	6,954	1,695	4,222
	1,337,456	1,427,141	1,663,100	1,725,261	1,731,812	1,853,473

TABLE IV

Breakdown of Domestic Consumption of Refinery Products — U. S. A.

	1942	1943	1944	1945	1946	1947(b)
Gasoline (M. gallons)						
Passenger cars	13,774,404	10,448,532	10,600,000	12,901,318	18,541,129	19,800,000
Motor trucks	5,420,646	5,103,168	5,416,009	5,925,682	6,826,923	7,451,000
Buses	739,200	764,400	798,991	800,000	826,948	864,000
All other uses	4,808,370	7,549,896	9,749,244	9,618,986	4,692,514	5,266,894
Total	24,742,620	23,865,996	26,564,244	29,245,986	30,887,514	33,381,894
Kerosene (M. bbl of 42 U. S. gal)						
Range oil	39,945	38,221	41,017	43,540	52,105	61,300
Tractor fuel	5,137	5,869	6,143	6,747	7,544	8,500
All other uses	23,608	23,725	24,054	24,689	28,441	32,707
Total U. S.	68,690	67,815	71,214	74,976	88,090	102,507
Exports and shipments	2,576	4,752	4,888	6,180	8,559	7,264
Grand total	71,266	72,567	76,102	81,156	96,649	109,771
Distillate fuel oil (M. bbl of 42 U. S. gal)						
Railroads	6,488	8,608	10,627	14,458	17,570	23,500
Vessels (including tankers)	8,900	11,069	13,187	14,130	12,064	13,500
Gas and electric power plants	5,704	5,954	5,837	6,824	10,581	14,000
Smelters, mines and mfg industries	12,617	15,125	16,953	19,071	21,317	24,500
Heating oils	121,506	112,581	111,729	121,342	142,637	176,000
No. 1 fuel oil sold as range oil	4,978	5,876	6,619	7,481	8,459	10,700
U. S. Navy, Army and Coast Guard	11,269	33,385	42,879	30,386	9,383	12,400
Oil company fuel	1,064	884	981	1,128	1,890	2,100
Miscellaneous uses	14,287	14,232	15,060	16,825	18,647	21,521
Total U. S.	186,813	207,712	223,872	231,625	242,550	298,221
Exports and shipments	21,575	24,957	43,491	33,496	29,353	29,929
Grand total	208,388	232,669	267,363	265,121	271,903	328,150
Residual fuel oil (M. bbl of 42 U. S. gal)						
Railroads	99,996	116,278	114,535	112,297	100,305	98,800
Vessels (including tankers)	37,817	62,196	92,069	100,365	88,185	99,000
Gas and electric power plants	28,101	30,858	34,476	34,532	50,921	59,500
Smelters, mines and mfg industries	84,515	33,995	37,616	43,351	52,720	49,123
Steel industry	(a)	50,224	49,048	47,825	42,457	51,677
Heating oils	47,483	42,670	40,474	43,874	49,734	58,000
U. S. Navy, Army and Coast Guard	56,531	92,713	101,347	97,485	35,822	33,600
Oil company fuel	44,871	47,123	55,363	57,336	58,054	62,700
Miscellaneous uses	6,019	6,420	4,484	5,200	5,028	5,994
Total U. S.	405,333	482,477	529,412	542,265	483,226	518,394
Exports and shipments	12,095	14,894	12,536	11,669	9,486	10,745
Grand total	417,428	497,371	541,948	553,934	492,712	529,139

(a) Figures not available.
(b) Figures in this column are estimated, except gasoline and residual fuel oil to steel industry.

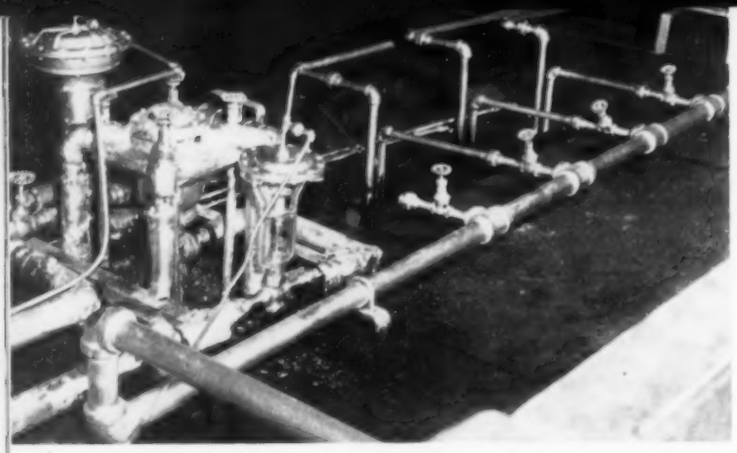


Figure 3 — This slab heating furnace for a plate mill uses a water cooled single steam jet oil burner.

more highly refined products are being produced at the expense of residual fuel oils. Some of the reasons [9]* for the demands of the higher refined products are given as follows:

1. 3,800,000 more passenger cars since 1941.
2. 1,500,000 more buses and trucks since 1941.
3. 1,600,000 more farm tractors since 1941.
4. Nearly 1,400,000 oil burners installed in 1946 and 1947.
5. Replacement of wood by kerosene in curing tobacco.
6. 93 per cent of all locomotives now on order will use diesel fuel.
7. Little or no conversion from liquid to solid fuels.

The question has been asked a good many times: "Is America running out of oil?" The answer is obvious: "Yes, but how soon?" The American Petroleum Institute "stresses the fact that its estimates of proved reserves cannot be used as a measure of the rate at which these reserves can be produced with or without physical waste. Oil cannot be produced from the permeable rocks in which it occurs at any desired rate, because the flow of oil through the pores of the oil-bearing rocks is definitely controlled by the physical factors of the reservoir. As a matter of fact, today's known oil can be recovered only over a period of many years and at gradually declining annual rates. Therefore, only incorrect conclusions as to the life of these reserves can be obtained by dividing these reserves by the current rate of production." [4]

The oil situation is worse than it first appears except for the fact that "we are continually discovering new crude reserves. With the exception of 1945 and 1946, we have discovered more new oil every year than we have used up. So our known reserves have kept increasing. But admittedly this cannot go on forever. Some time the law of diminishing returns will catch up. What then? [7].

The following trends and developments are now in use to augment the supply of petroleum and for decreasing the demand for same:

1. The piping of natural gas, principally from Texas, Louisiana, Kansas, etc., to the northern states.
2. Powdered coal (325 mesh) fired gas turbines.
3. Powdered coal (325 mesh) fired small industrial furnaces, boilers, etc.
4. Powdered coal (325 mesh) fired domestic furnaces, boilers, etc.
5. Gasoline and oils from natural gas synthesis.
6. Gasoline and oils from coal synthesis.
7. Gasoline and oils from oil shales.

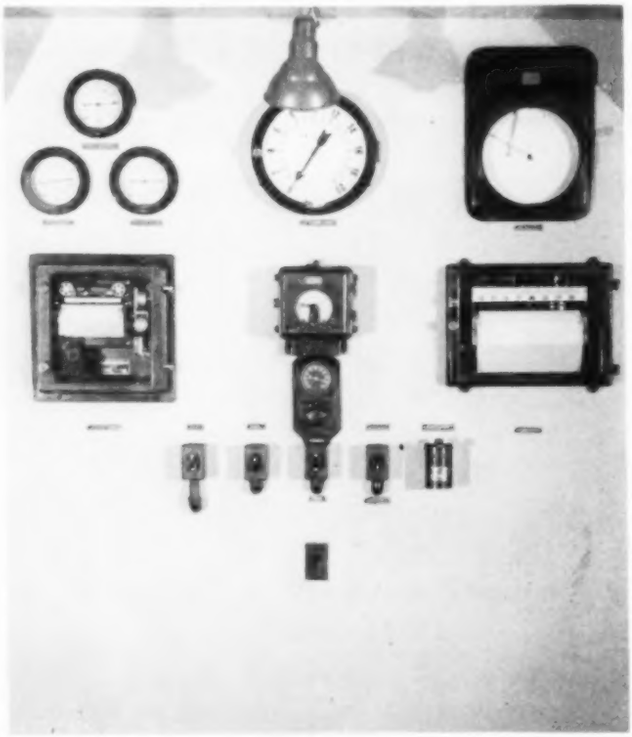


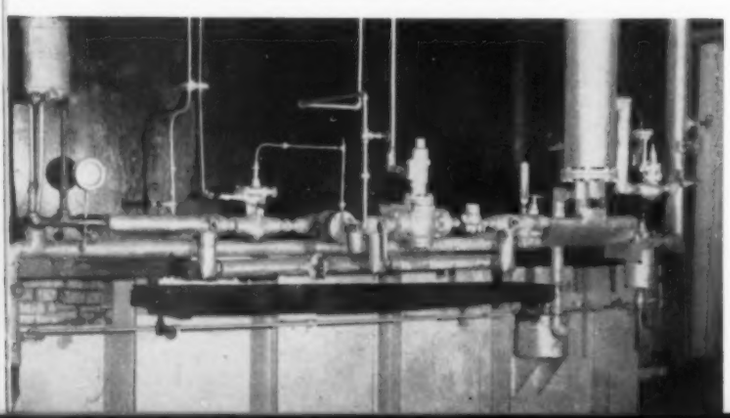
Figure 5 — The controls for the furnace in Figure 3 are mounted on one panel board.

8. Gas from coal synthesis.

To us in America "the search for new oil sources is a ceaseless one because we are all in competition. We all have the incentive to find those sources first. That is why you can flatly guarantee that as long as this country retains free competitive economy, adequate oil supplies will continue to be found . . . probably for hundreds of years to come." [7]

*Numbers in parenthesis refer to bibliography at end of article.

Figure 4 — The control for one of the furnaces shown in Figure 3 is illustrated in this photograph.



THE DEVELOPMENT OF FIRE

Looking back into prehistoric times, it is fairly easy to imagine how fire was first produced and how it was used. Then later, historically, we have a fairly accurate

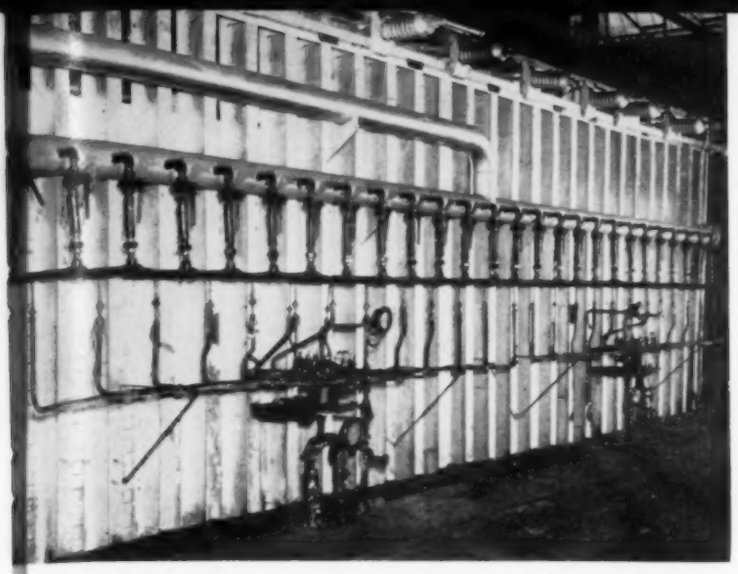


Figure 6 — Twenty-six burners are fed by two steam-oil mixers in parallel.

record of the development of fire. To the inquisitive it unfolds something like this:

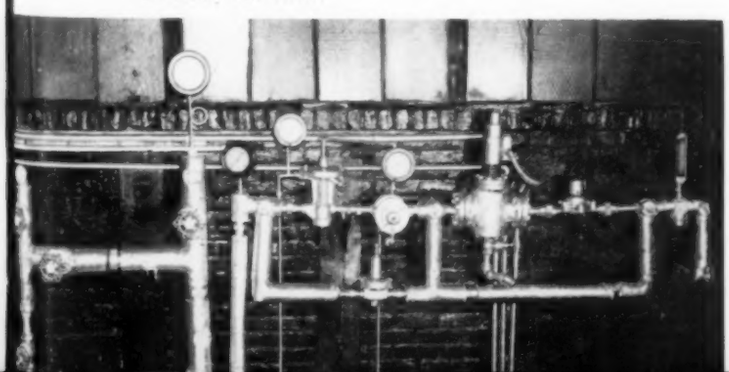
The first fires during man's stay on the earth were of two origins, volcanic eruption or lightning. Early fires were started and coveted from these sources. Embers were taken in protected vessels from place to place, one fire was started from another.

Wood—Prehistoric fires were wood fires in open places. Later charcoal fires were used in caves and confined places. These early fires led to the rendering of animal fats and to the wick in the bowl light which was subsequently developed into the tallow candle. Prehistoric fires were later started by rubbing sticks together.

Coal—The earliest use of a black sedimentary rock as fuel is not known. However, the first recorded use of this rock was in England and is frequently stated to be in the year 852. The rock was named "coal" meaning black. Coal was first made into coke in the year 1590 when a patent was granted to John Thornborough of England. Coke could be burned in poorly ventilated places as compared to coal, since all of the obnoxious fumes had already been distilled off. The art of finely grinding coal and burning it in suspension was first tried by Joseph Niepce in 1818.

Match—The friction match for producing fire was dependent on the discovery of phosphorus which was isolated accidentally by Brand of Hamburg in 1670. Thereafter many kinds of matches were made, most of which were very dangerous to ignite until John Walker, an English druggist, made the first really useful match in 1827.

Figure 7 — Oil flow control for heating furnace in a continuous rod mill.



Electricity—Electricity was first generated by Faraday in 1831. However, it was not until 1882 that electricity came into its own by reason of the refinements of Edison. His developments in central station power production, and the invention of the electric light led to the world wide use of electricity as a tool for light, power and heat.

Oil—The first use of petroleum as a fuel undoubtedly took place along the western shore of the Caspian Sea. Oil was close to the surface here and seepage to the surface occurred in many places. The early oil wells in the region were all hand dug wells. These wells were known as the Baku oil pits and were usually 40 to 100 ft in depth.

The American Indians also knew of petroleum. It occurred as oil seepage in areas that are now in New York state. They used it for "making glorious fires during religious ceremonies and dances." However, the greatest use for this oil was for hair ointment or as medicine. Like the early Persians and Armenians, they used it in great quantities. When the white man came to America he followed in the Indian's footsteps in

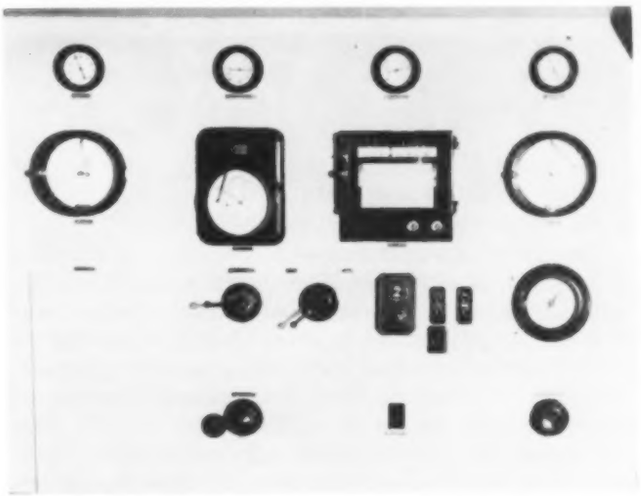


Figure 8 — Instrument panel board for heating furnace for continuous rod mill.

ascribing medicinal properties to petroleum. These early bottled oils were known as "Seneca Oils," a name well known in drug stores to this day.

Although many salt wells in America were ruined by seepage of oil, it was not until 1845 that the thought developed that oil could be produced by drilling. Events led up to the drilling of the first oil well and at 69½ ft, E. L. Drake "struck oil" on Oil Creek, near Titusville, Pa., on August 28, 1859. Since all Russian wells were hand dug prior to Drake's well, it was not long thereafter that "the drill was bringing in fountains of oil in the land of the Muscovite."

On January 10, 1901, an event in fuel oil production took place, almost as epochal in character as Drake's well. It was the bringing in of the Lucas gusher at Beaumont, Tex. This well produced more than 100,000 barrels per day. The well was readily accessible to land and sea transportation. The oil, as it came from the well, was easy to burn and the price was low. Vast quantities went on the market. Everybody began to think about burning oil, the main question was: How?

DEVELOPMENT OF OIL BURNERS

The making of oil burners soon developed into the great American pastime for laymen, engineers, and plant operators alike. Everyone became oil burner conscious. The problem was to lay the required amount of oil fire of the proper shape and character, in a given space, at the desired time. Although some of these steps were easy to accomplish by hand, it has only been very recently that all of them have been produced and activated by automatic controls from pressure, flow, time, temperature, and chemical analysis.

V-trays—The first oil burners consisted of a series of V-shaped trays patented by Nobel in 1853. Air for combustion was created by natural draft and passed upward between the trays. Control was difficult, if not impossible.

High Pressure Steam and Air Atomization—Fuel oil burning in large capacities was not successful until 1865. At this time two revolutionary ideas appeared in which the oil was burned in suspension. Aydon, an Englishman, used superheated steam for atomization, while Schpokofsky, a Russian, used compressed air.

Revolving cup—Cook, an American, developed a method of spraying oil by mechanical means in 1868. His patent claimed "the introduction and distribution by centrifugal force of liquid hydrocarbon into burners as fuel." Cook was many years ahead of his time and it was not until 1910 that the revolving cup idea was revived in order to save steam and water, especially on galley stoves and boilers for marine purposes.

Mechanical Atomization — Mechanical atomization of fuel was developed in 1882. Koerting and Schutte, both Germans, and Hogan, an American, were pioneers in producing the mechanical atomizer. The British navy developed fuel oil burning for marine purposes and after several attempts at steam atomization turned to mechanical atomization in 1903. Later, in 1913, Peabody, an American, developed ways and means of burning fuel oil on American battleships by use of mechanical atomization. The wide range mechanical burner came into use in the year 1920. Mechanical atomization is now almost universally used on marine boilers with modulating control and on domestic furnaces with on-and-off control.

Low pressure air atomization—A considerable number of small industrial furnaces, using cold air for combustion, are fired with 1½ lb air atomization in which the oil pressure is maintained constant against a variable orifice. Burners with mechanical linkages have been evolved using combinations of variable oil, gas and air valves, either singly or in parallel.

Oil controls—Steam and air atomization of oil is used primarily on furnaces where the combustion air is heated separately, either by means of recuperators or regenerators. Early oil burning applications to large industrial furnaces were all of this type. Hand control of oil was used. The flame was set by the heater's eye. High fuel rates, excessive refractory erosion resulted, and the overheating of the product occurred all too often.

Bethlehem Steel Co., recognizing this condition, was instrumental in 1930 in designing the area oil flow meter, the oil differential static converter, and the oil flow control valve. These devices made it possible to accurately control oil by means of air operated potentiometers, flow meters, pressure gages, etc. They are all outlined in the writer's paper, "Oil Burning and Its Control," printed in the Association of Iron and Steel Engineers Yearbook for 1938. Since 1930, control engineers have been instrumental in making improvements in these devices and many rugged and accurate types are being offered today.

Figure 9 — A large billet heating furnace has twelve burners, fed by a single steam-oil mixer.

Steam and air-oil mixers—Probably the greatest lift to steam and air atomization burning of fuel oil was made by Bethlehem Steel Co. in 1937, when the steam and air-oil mixers were developed. In this device, single oil and steam lines (or oil and air lines) leading into a mixer could easily be controlled. A plurality of feed pipes to burners ranging from one to twenty are possible, all operating in parallel with equal amounts of the total oil flow. This device is also outlined in "Oil Burning and Its Control." Applications range from twelve mixers of 10 gallons input per hour, each feeding ten 1-gphr, on a continuous butt-weld furnace, to one mixer of 500-gphr input feeding twelve 42-gphr outlets on a large billet heating furnace.

Application of oil to industry—Inasmuch as it would be difficult and almost impossible to put down here the many applications of oil burning in the steel industry of the United States of America, and since the author has previously outlined his experiences in "Oil Burning and Its Control;" suffice is to say that, in our industry, we can burn any kind of fuel oil, without smoke, and with maximum efficiency. We can burn it with forced draft at high capacity; or with natural draft in moderate amounts. We can burn it with horizontal firing; or vertically up; or vertically down firing; or criss-cross firing. We can burn it singly; or in combination with gas and/or pulverized coal; or all three together. We can burn it under stills, under boilers, furnaces, retorts, air heaters, or, under anything. We can burn it in furnaces lined with firebrick; or in black furnaces, the walls

of which are lined with water tubes. We can burn it in little furnaces to heat small buildings and offices.[1]

The years 1920 to 1935 represent a period in which considerable thermal efficiency was introduced into the steel business by means of instruments and controls, and trained instrument mechanics, control mechanics, combustion engineers and fuel engineers. By-product gas fuels were extended and fuel oil was used to fill in the vacant areas, thereby reducing the need for coal.

The years from 1935 to 1941 were truly the fuel oil period in the steel industry. Large quantities of fuel oil were available, and in many areas it was cheaper than coal, Btu for Btu.

The war years, 1941-1945, saw great military demands placed on oil, and civilian and industrial use of fuel oil was controlled by means of rationing boards set up throughout the land. The public and industry was forced to think about coal and how it could be used to replace oil.

The post war trend, 1945-1948, is still from oil to coal, or to fuels produced from coal. The steel industry is now trying to establish a coal basis in their operations. Catalytic cracking has enabled the oil industry to produce larger quantities of gasoline, kerosene, and distillate oils at the expense of residual oils. The installation of more and more of these "cat crackers" will mean less and less residual oils, ultimately tending to force heavy industry back into the use of coal. This trend is clearly shown in Tables III and IV. The steel industry is meeting this situation in the following manner. Blast furnace gas is being used to underfire coke oven batteries and soaking pits. The coke oven gas thus liberated is being used in the open hearth furnaces up to about 50 per cent replacement without a loss in steel production, and boilers are being fired with powdered coal and coke breeze to replace the blast furnace gas. If fuel oil will ultimately have to be replaced entirely by coal, the second step will be to increase the use of coke oven gas to the open hearth, supplemented by a manufactured gas of similar characteristics to about 70 per cent of the total open hearth requirements augmented by 30 per cent firing of tar or pitch for luminosity and flame radiation requirements. The manufactured gas could then also be used in the heating and treating operations to entirely eliminate fuel oil from the steel making picture. This shift from oil to coal will of necessity have to take place gradually as local conditions warrant.

Master plans for making this change in fuels should be set up in each plant and no opportunity should ever be missed in designing the plant to accomplish this purpose.

The increase in the costs of fuels, due to scarcity or otherwise, provides the incentive for the fuel engineers to develop more efficient equipment for using it. Table V shows this effect for the electrical industry, and Table VI shows it for the steel industry.

The present relation of oil to coal in steel making is

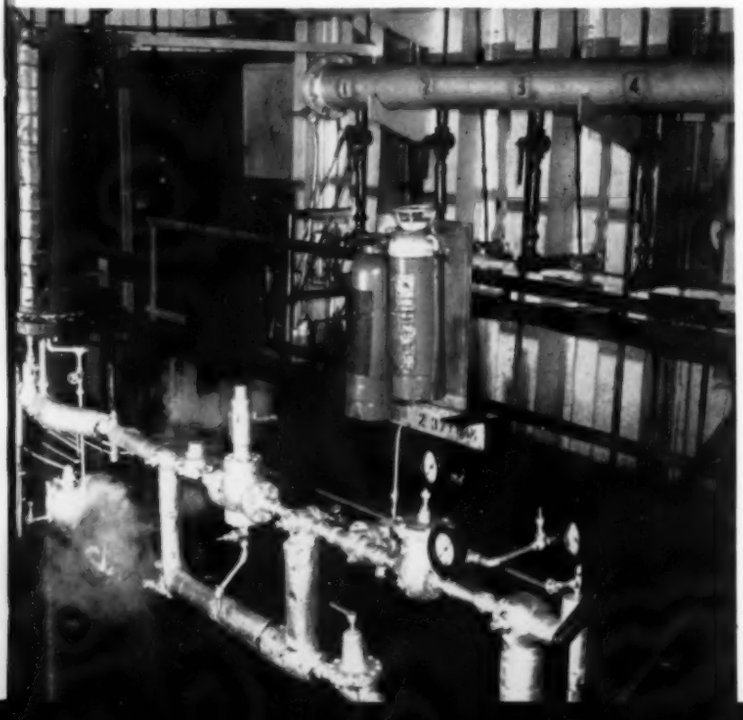


Figure 10 — Oil control for large billet heating furnace.

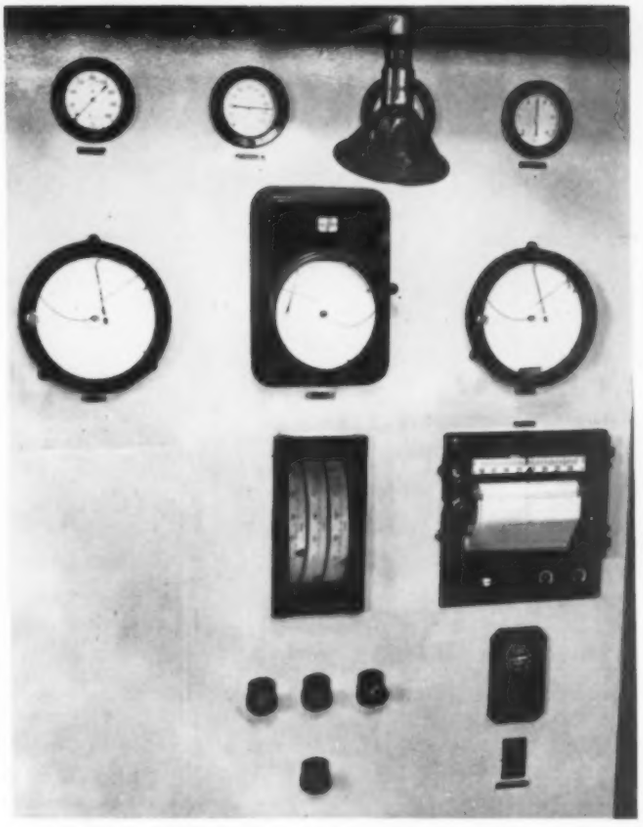


Figure 11 — Instrument panel board for large billet heating furnace.

TABLE V

Fuel Trends in the Electrical Industry — USA

Year	Lb of coal per kwhr generated	
	Consolidated Gas, Electric Light & Power Co. of Baltimore	Entire public utility industry (8)
1920	2.12	3.39
1925	1.53	2.10
1930	1.39	1.60
1935	1.25	1.44
1940	1.28	1.34
1945	1.04	1.30
1946	1.05	1.29
1947	1.13	1.31

TABLE VI

Fuel Trends in the Steel Industry — United States of America

Year	Tons of coal equivalent per ton of ingots	
	Five major Bethlehem plants	Steel industry, USA
1929	1.32	.....
1930	1.32	.....
1931	1.25	.....
1932	1.46	.....
1933	1.26	.....
1934	1.26	.....
1935	1.15	.....
1936	1.11	.....
1937	1.12	.....
1938	1.18	.....
1939	1.05	.....
1940	1.03	.....
1941	1.00	.....
1942	1.05	.....
1943	1.06	1.15
1944	1.07	1.17
1945	1.07	1.20
1946	0.95	1.28
1947	1.07	1.25

TABLE VII

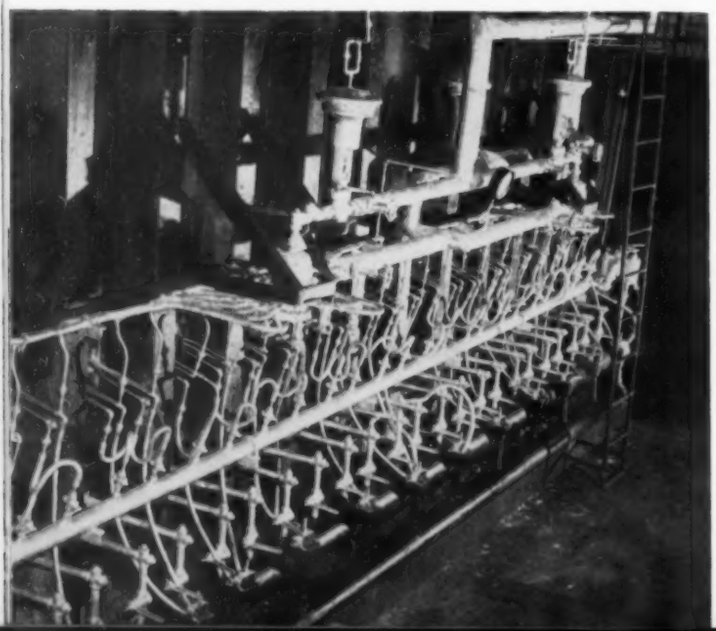
Relation of Coal to Fuel Oil — 1947

Fuel	Five major Bethlehem plants	Steel industry, USA
Coal — tons per year	11,777,977	94,271,992
Fuel oil — M. gal per year	344,000	2,170,450
Coal, per cent	83.9	87.2
Fuel oil (coal equivalent), per cent	16.1	12.8
Tons ingots produced (1947)	12,267,112	84,783,981

interesting. (See Table VII). The future relation will be influenced greatly by the geographical location of the plants in respect to the coal and oil fields and by the availability and price of fuel oil. The steel industry is basically a coal consuming industry. Blast furnaces require large quantities of coke, and coke is made from coal in coke ovens. The by-product gases made in these two operations are now used throughout the steel plant. The extent of their use is a function of the thermal efficiency of each application. By good engineering and plant operation, in respect to their use, purchased fuels such as fuel oil can be kept to a minimum.

The reason for the Bethlehem plants using a larger percentage of fuel oil (See Table VI) than the industry is because three of the plants sell large quantities of coke oven gas to nearby cities for domestic consumption. Public utilities must generate gas from oil and coke. Gas sales from steel plants to public utilities save the conversion loss in the gas making thermal reactions, inasmuch as fuel oil and coke can be applied directly to steel mill furnaces without the conversion loss.

Figure 12 — Twenty-three water cooled single jet burners, fed by two steam-oil mixers in parallel, are used to apply coke oven gas and fuel oil to this skelp furnace.



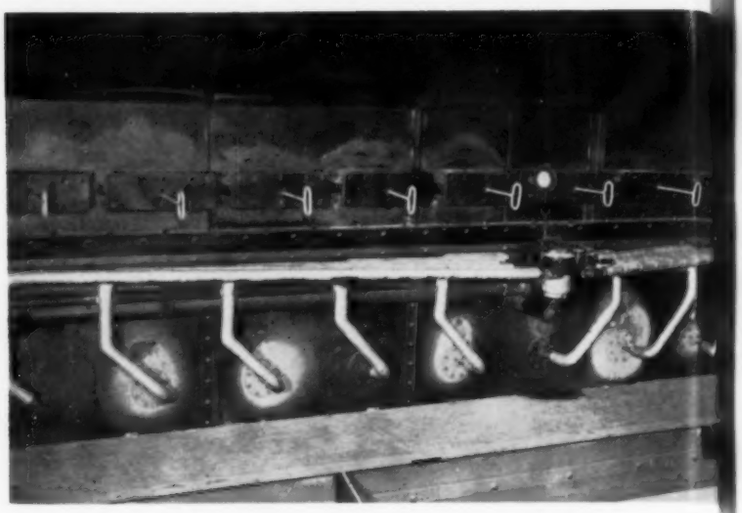


Figure 13 — The steam-oil mixer and oil burner for one zone of a three zone slab heating furnace for a 68 in. strip mill are shown in this figure.

APPLICATIONS OF FUEL OIL

The use of fuel oils in the various phases of the steel industry, without too much attention to detail, is given in the following discussion:

Coke Ovens—The control of the bulk density of coal, or weight per cubic foot, is a major factor in producing uniform coke at the coke ovens. Bulk density is a function of the degree of fineness of the coal and its moisture content. It is desirable to fine grind coals with high ash content to get uniform distribution of the ash and stronger coke for blast furnace use. Fine grinding decreases the bulk density and lowers the tons of coal per oven charge. The bulk density can be increased on finely ground coals by the addition of 0.2 to 0.5 gallons of fuel oil per ton of coal. The oil is added to the coal before fine grinding takes place. The use of oil causes the facets of the coal particles to stick face to face and thereby take up less space than before.

Most of the coke oven batteries operated for gas making and domestic coke use oil in the neighborhood of 2 to 4 gallons per ton of coal for increasing gas yield only. However, only a very small percentage of the batteries making metallurgical coke use oil, and then only to correct bulk density because of fine grinding of the coal.

The major effects of adding oil to the coke oven coal are as follows:

1. The bulk density of the coal is more uniform throughout a variation of the moisture content of the coal.
2. Oiling of the coal increases the bulk density on all coals except those that are very dry.
3. The excessively high and dangerous bulk densities of low moisture content coals can be lowered by the use of oil up to and including 2.0 gallons of fuel oil per ton of coal.
4. The angles of repose of the oiled coal is less than than those of corresponding unoiled coals of the same moisture content.

Blast furnaces—Fuel oil is sometimes used to fire blast furnace stoves in plants where there is need for the blast furnace gas for metallurgical purposes. It is also used to heat a single stove in a plant for starting up blast furnaces that have been banked.

The oil firing rate may vary from 150 to 200 gphr, depending on the size of the stove. Care must be taken not to overheat the ignition tunnel beyond 2300 F. For this reason, it is necessary to use about 100 per cent excess air. Maximum dome temperature corresponding to 2300 F in the tunnel is 2100 F.

Stoves have been operated in our Bethlehem plant on fuel oil as regular practice by using mechanical oil atomizers. At Sparrows Point, stoves have been heated to operating temperatures for starting up banked blast furnaces by means of steam-oil mixers and multi-jet burners.

Stoves for special purposes have been heated by steam-oil mixers and water cooled multi-jet burners installed in the dome of the stove. This entirely eliminates the ignition tunnel and the stove can be operated at higher temperatures with less excess air. In this case, care must be taken not to cool the stove below ignition temperature, say 1000 F, otherwise it would have to be preheated again by side door burners located at the top checker level, using 1½ lb air for atomization.

Open hearth furnaces—The open hearth furnaces are the greatest consumers of fuel oil in the steel industry. The industry used 51,677,000 barrels of oil in 1947 and approximately 65 per cent of this amount was consumed by open hearth furnaces.

Open hearth fuel oil should always be specified. It is a well known fact that heavy fuel oils are better for

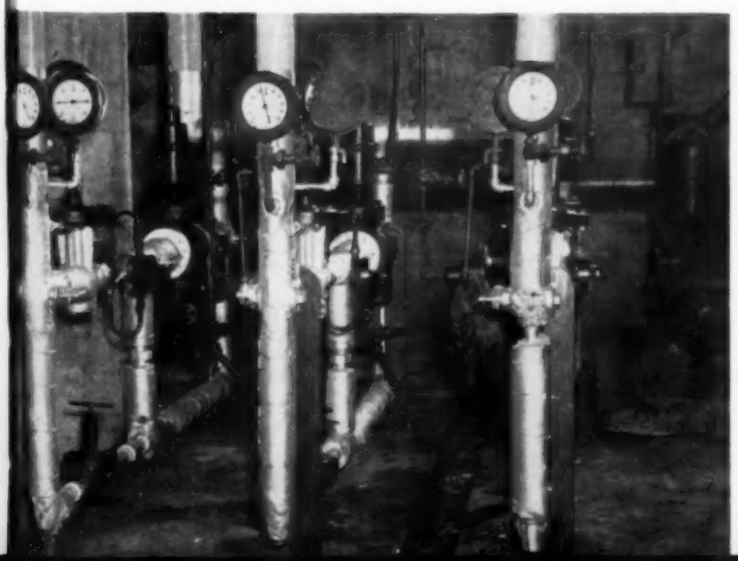


Figure 14 — Showing oil flow control units for three zones of a slab furnace.

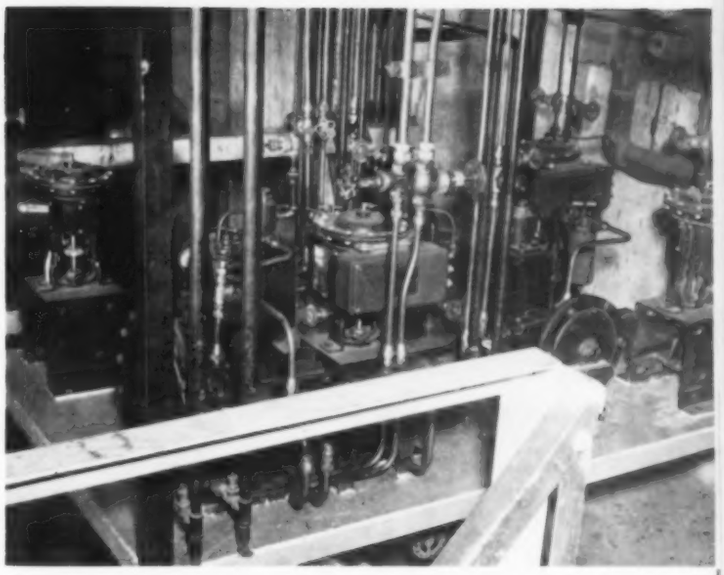


Figure 15 — The furnace pressure and combustion air regulators are located away from the furnace.

open hearth work than light oils; and that coke oven tars and topped tars are successively better than heavy fuel oils. The reason for this is the necessity of transferring a large amount of heat by radiation from the early part of the protracted liquid fuel flame. If the heat is not radiated in the early part of the flame, it necessarily is liberated later which results in a lower heat transfer to the bath and excessive refractory burning in the outgoing end. This condition calls for a reduction of fuel to save the furnace with an ultimate loss in production. A specification for open hearth fuel oils is shown on Table VIII.

TABLE VIII

Combustion Rating
Fuel Oil for Open Hearth Use

Rating	API gravity	Viscosity (Saybolt — 122 F)
"Very Good"	5.0 to 9.9	150 to 100
"Good"	10.0 to 14.9	99 to 72
"Poor"	15.0 to 19.9	71 to 44
"Very Poor"	20.0 to 25.0	43 to 15

Use of Scale:

1. If the viscosity rating is lower than the specific gravity rating, use the rating corresponding to the viscosity.
2. If the viscosity rating is higher than the specific gravity rating, use the rating corresponding to the specific gravity; unless the viscosity rating is two (2) ratings higher, in which case, use the next higher rating above the specific gravity rating.
3. Sulphur control in all cases to be below 1.0 per cent.

It has been generally proven that higher sulphur oils require more limestone in the charge, which causes longer time of heats and higher sulphur content in the steel. Tests have been run at our Bethlehem plant relative to the effect of using 2.0 per cent sulphur oil as against 1.0 per cent. The average of 65 heats showed an increase of 0.006 per cent sulphur in the steel. Tests were not run on maintaining constant sulphur analysis in the steel with high and low sulphur fuels.

There are not many low-sulphur oil fields in the United States and as production falls off in these fields, low sulphur fuel oil for open hearth use will decline unless new fields are discovered. The industry is becoming aware of this fact and is now in need of ways and means of burning high sulphur fuel oils in the open hearth without excessive increases in cost.

The preferred method of burning fuel oil is to use steam-oil mixers for melt-down and practically no mixing after melt-down in conjunction with water-cooled multi-jet oil burners. Such a burner is shown installed on a 215-ton open hearth (See Figure 1). This burner gives a high temperature, low luminous flame for melting down and a low temperature, high luminous flame after melting down.

Open hearth fuel oils varying widely in viscosity can be partially compensated for in order to maintain proper flame radiation. A combustion schedule for oil fired furnaces tapping 150, 165, 185 and 215 tons are shown by Tables IX, X, XI, and XII. The effect of

TABLE IX

Combustion Schedule for Furnaces Tapping 150 Ton Heats —

Multi-jet Burners
Open Hearth Furnace
"Very Poor" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	90	80-90	80	100
Mixer				

Oil flow — maximum	450 gphr
Air flow — constant	10,500 cfm
Dead end steam pressure	10 psi
Steam temperature	400 F
Oil temperature	100 F

"Poor" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	100	90-100	90	110
Mixer				

Oil flow — maximum	450 gphr
Air flow — constant	10,500 cfm
Dead end steam pressure	10 psi
Steam temperature	435 F
Oil temperature	120 F

"Good" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	110	100-110	100	120
Mixer	USE			

Oil flow — maximum	450 gphr
Air flow — constant	10,500 cfm
Dead end steam pressure	10 psi
Steam temperature	470 F
Oil temperature	135 F

"Very Good" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	120	110-120	110	130
Mixer	USE			

Oil flow — maximum	450 gphr
Air flow — constant	10,500 cfm
Dead end steam pressure	10 psi
Steam temperature	500 F
Oil temperature	150 F

TABLE X

Combustion Schedule for Furnaces Tapping 165 Ton Heats —

Multi-jet Burners
Open Hearth Furnace
"Very Poor" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	100	80-90	80	100
Mixer				

Oil flow — maximum	500 gphr
Air flow — constant	11,250 cfm
Dead end steam pressure	10 psi
Steam temperature	400 F
Oil temperature	100 F

"Poor" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	110	90-100	90	110
Mixer				

Oil flow — maximum	500 gphr
Air flow — constant	11,250 cfm
Dead end steam pressure	10 psi
Steam temperature	435 F
Oil temperature	120 F

"Good" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	120-110	100-110	100	120
Mixer	USE			

Oil flow — maximum	500 gphr
Air flow — constant	11,250 cfm
Dead end steam pressure	10 psi
Steam temperature	470 F
Oil temperature	135 F

"Very Good" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	130-120	110-120	110	130
Mixer	USE			

Oil flow — maximum	500 gphr
Air flow — constant	11,250 cfm
Dead end steam pressure	10 psi
Steam temperature	500 F
Oil temperature	150 F

varying the pressure and temperatures of the steam and oil only partially compensate for the low oil viscosities. Therefore, there is still a great demand, in most open hearths, for a uniformly heavy fuel oil. Given a specified heavy oil, it then becomes an easy matter to design a burner that will produce the right size and character of flame to fit the furnace. Inasmuch as 65 per cent of the fuel oil used in the steel industry is for open hearth furnaces, oil companies could certainly enhance a sizeable portion of their product by making an open hearth fuel oil. The amount of such a product would be approximately 33,590,000 barrels per year.

The steel industry is now considering ways and means of stabilizing the flame radiation effect of fuel oils by the addition of low ash 325 mesh coals. Oils could be stabilized at heavy fuel oil values, tar values, or topped tar values as desired.

A stabilized oil will surely increase the steel making capacity of open hearth furnaces as well as effect a considerable refractory savings.

TABLE XI

Combustion Schedule for Furnaces Tapping 185 Ton Heats —

Multi-jet Burners
Open Hearth Furnace
"Very Poor" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	110	80-90	80	100
Mixer				

Oil flow — maximum	550 gphr
Air flow — constant	12,450 cfm
Dead end steam pressure	10 psi
Steam temperature	400 F
Oil temperature	100 F

"Poor" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	120	90-100	90	110
Mixer				

Oil flow — maximum	550 gphr
Air flow — constant	12,450 cfm
Dead end steam pressure	10 psi
Steam temperature	435 F
Oil temperature	120 F

"Good" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	130-120	100-110	100	120
Mixer	USE			

Oil flow — maximum	550 gphr
Air flow — constant	12,450 cfm
Dead end steam pressure	10 psi
Steam temperature	470 F
Oil temperature	135 F

"Very Good" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	140-130	110-120	110	130
Mixer	USE			

Oil flow — maximum	550 gphr
Air flow — constant	12,450 cfm
Dead end steam pressure	10 psi
Steam temperature	500 F
Oil temperature	150 F

TABLE XII

Combustion Schedule for Furnaces Tapping 215 Ton Heats —

Multi-jet Burners
Open Hearth Furnace
"Very Poor" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	110	80-90	80	100
Mixer				

Oil flow — maximum	568 gphr
Air flow — constant	12,750 cfm
Dead end steam pressure	10 psi
Steam temperature	400 F
Oil temperature	100 F

"Poor" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	120	90-100	90	110
Mixer				

Oil flow — maximum	568 gphr
Air flow — constant	12,750 cfm
Dead end steam pressure	10 psi
Steam temperature	435 F
Oil temperature	120 F

"Good" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	130-120	100-110	100	120
Mixer	USE			

Oil flow — maximum	568 gphr
Air flow — constant	12,750 cfm
Dead end steam pressure	10 psi
Steam temperature	470 F
Oil temperature	135 F

"Very Good" Fuel Oil

	Melt	Ore	Lime	Work
Furnace reversal — min	15	10	10	10
Steam pressure — psi	140-130	110-120	110	130
Mixer	USE			

Oil flow — maximum	568 gphr
Air flow — constant	12,750 cfm
Dead end steam pressure	10 psi
Steam temperature	500 F
Oil temperature	150 F

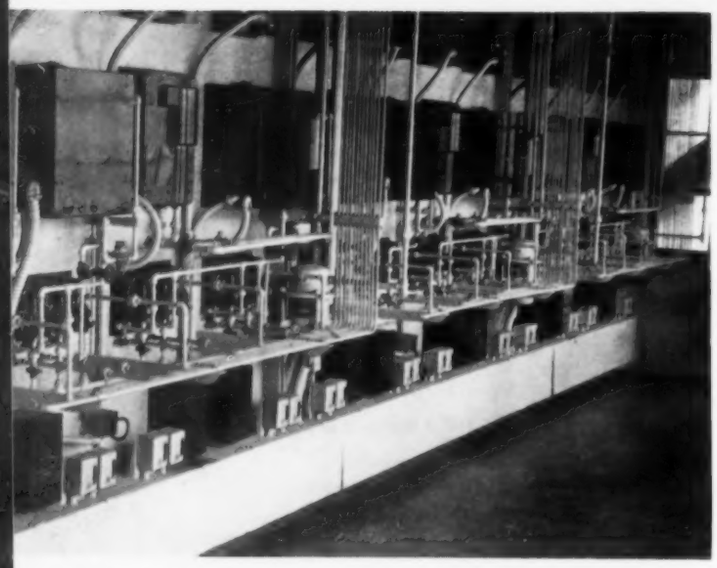


Figure 16 — Back of instrument panel for slab heating furnace.

cent of the average total fuel input have been used without a loss in steel production and thermal efficiency, and without any additional refractory erosion.

2. Coke oven gas and oil fired furnaces tapping 100 to 175 tons—Gas pressures of approximately 6 lb gage are used against nozzles of 2½ to 3 in. diameter with a single jet steam oil burner in the center of the nozzle. The oil burner must be used to entrain the gas and to furnish the desired luminosity. This type of burner may be used on furnaces tapping between 100 and 175 tons.

Care must be exercised to keep the gas nozzle clean at all times, otherwise the maximum gas flow will be curtailed.

Table XIII shows a fuel schedule on a combination gas and oil fired furnace tapping 160 net tons. Average charge-to-tap time for a test run of 35 heats was 9 hours and 3 minutes.

Rates of gas consumption equivalent to 50 per cent of the average total fuel input have been used without a loss in steel production, thermal efficiency, and without any additional refractory erosion.

TABLE XIII

Firing Schedule

500 Btu Coke Oven Gas and Fuel Oil Schedule — 160-Ton Tap

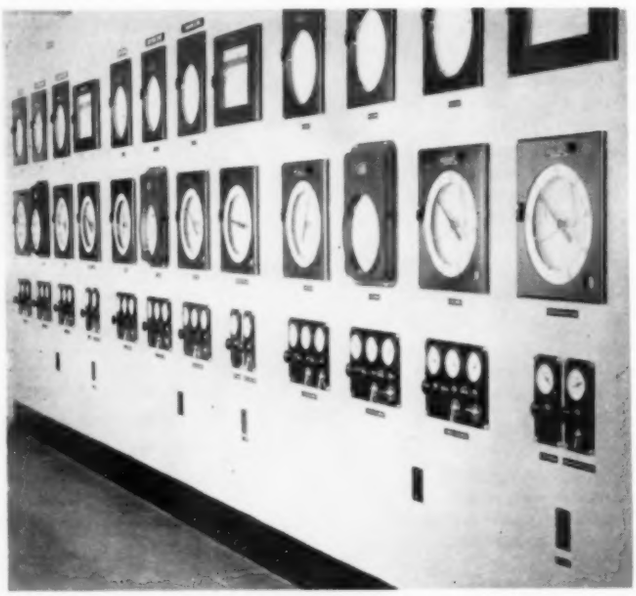
Period	Oil, gphr	Gas, million cfhr	Total fuel input in oil, gphr	Air, cfm	Steam, psi
Charging	100	Quick charge 135,000 Slow charge 120,000	560 500	12,500	20
First ladle hot metal	200	90,000 or less	500	11,100	30 to 60
Lime boil	400	.....	400	11,100	100 to 120
Working heat	200	75,000 or less	450	11,100	30 to 60
Making bottom	.....	60,000 or less	200 plus	.....	20

The factors relating to open hearth flames have been disclosed by the author in his papers, "Relation of Flame Character to Open Hearth Operation," in the 1941 and 1943 Yearbook of the Association of Iron and Steel Engineers, and in the 1944 Open Hearth Proceedings of the AIME, and "Items of Controllability in the Open Hearth Process," 1947 Yearbook, American Iron and Steel Institute.

There is much time and effort now being expended on combination fuel oil and coke oven gas burners for open hearth use. This is in connection with the change from fuel oil to coal or fuels produced from coal. This work has been divided into three parts, as follows:

1. Coke gas and oil fired furnaces tapping 50 to 100 tons—Gas pressures of approximately 20 in. water column are used against nozzles of 5.5 in. in diameter surrounding a single hole or multi-jet steam oil burner. The oil burner must be used to entrain the gas and to furnish the desired luminosity. A maximum of 110,000 cu ft of gas can be used, which is enough fuel for melting down purposes. This burner is used with considerable success on furnaces tapping between 50 and 100 tons. Rates of gas consumption equivalent to 50 per

Figure 17 — Front of instrument panel for slab heating furnace.



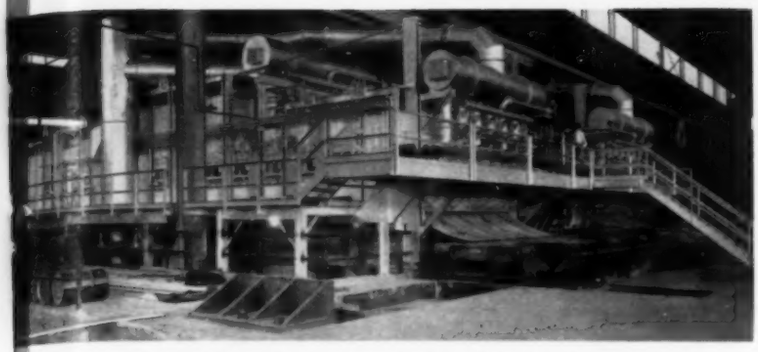
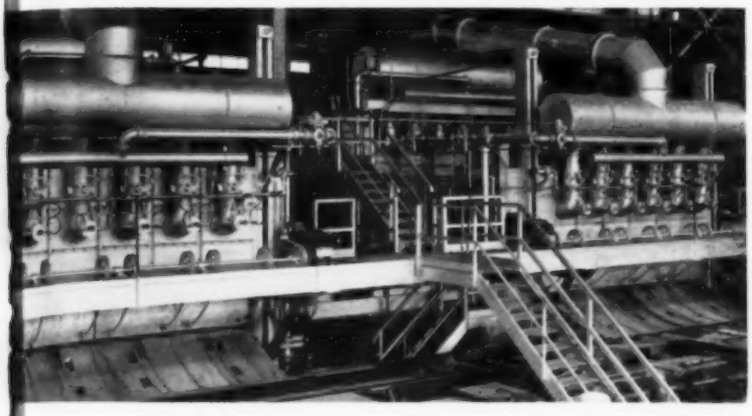


Figure 18 — These three-zone slab heating furnaces are equipped to use both gas and oil.

Figure 19 — The gas and oil valves of this furnace are operated through mechanical linkages.



By using 50 per cent coke oven gas fuel, according to the schedule on Table XIII, coke oven gas at 450 grains of sulphur per 100 cu ft, the per cent sulphur in the steel increased 0.007 per cent. Therefore, it is deemed desirable on most grades of steel to remove the sulphur from the coke oven gas prior to burning.

3. Coke oven gas and oil fired furnaces tapping 175 to 225 tons—Because of the length of these large furnaces, higher coke oven gas pressures may become necessary. Some preliminary tests have already been conducted in this direction.

Boilers—Most steel plant boilers are fired with by-product fuels, blast furnace gas and coke breeze mainly. In many plants auxiliary fuel oil firing is used for replacing blast furnace gas when a blast furnace is off the line, for filling in the valleys of a variable blast furnace gas supply, and for pilot burners in water walled fire boxes.

Although the amount of fuel oil used for boiler firing is not large when compared to the total fuel oil used in the steel industry, there is, however, a substantial need for boilers capable of burning blast furnace gas, backed up by mixed powdered coke breeze and coal firing. The reason for this need is the fact that chain grates, burning coke breeze, have not been built exceeding about 175,000 lb of steam per hour; that bituminous coal and coke breeze cannot be burned together on a chain grate; that grates are too sluggish to follow swings in both blast furnace gas flows and steam demands; that larger boilers than 175,000 lb per hour are now in demand; and that higher air preheats can be used on powdered fuels than on chain grate fuels.

Soaking pits—Soaking pits in integrated steel plants, having coke ovens and blast furnaces, are usually fired with gas. Gas of 100 to 110 Btu per cu ft is the desired fuel because of its low hydrogen and sulphur content, and its low flame temperature. This gas is obviously mostly blast furnace gas and can only be used on regenerative pits giving an air preheat temperature around 2000 F. On recuperative pits, with lower air preheat, higher Btu gas is required, in the neighborhood of 150 Btu or higher.

In non-integrated steel plants, having insufficient or no coke oven and blast furnace gas, natural gas supplemented with oil or straight oil firing is used. The oil flow must be controlled from pit temperature, otherwise the excessively high flame temperature will do damage to the brickwork of the pit, and also wash and/or burn the ingots.

Pits up to 14½ x 20½ ft are top fired by single jet steam atomization oil burners. The recuperative pit shown in Figure 2 can be fired with gas and/or oil. Steam atomized, single jet oil burners are used for this

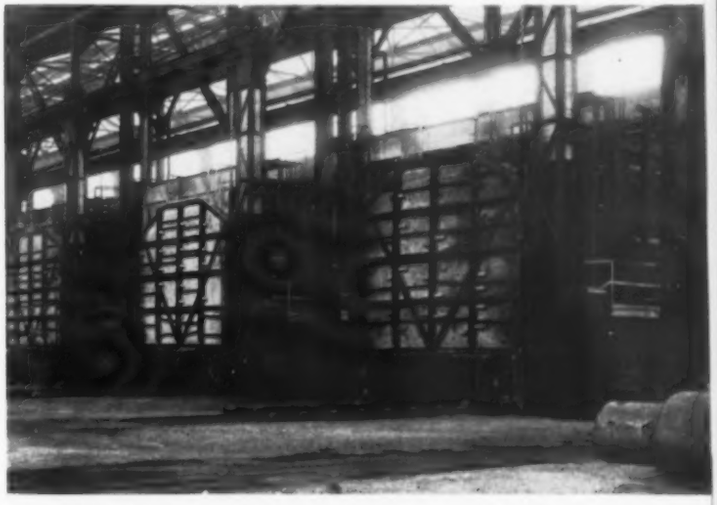
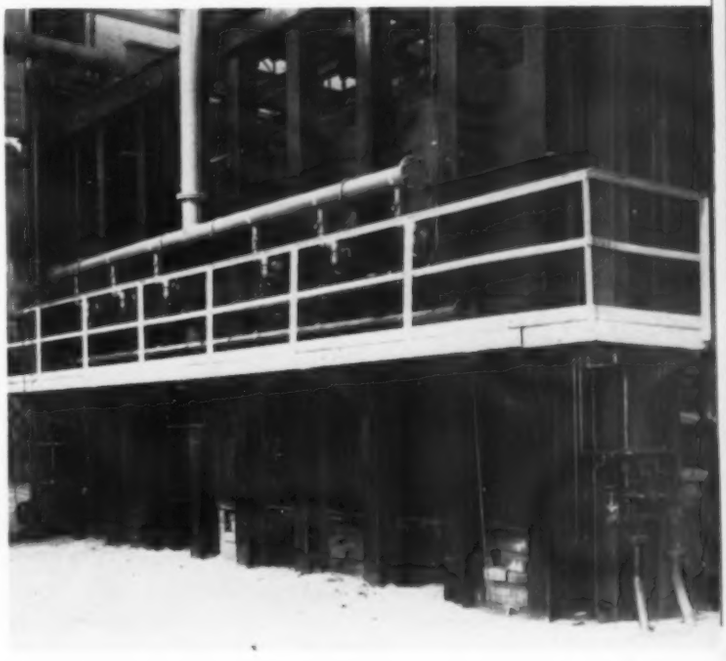


Figure 20 — The three forge heating furnaces shown in this figure are part of a battery of seven and are of the car-bottom type.

Figure 21 — The burners for the furnaces shown in Figure 20 are illustrated here in greater detail.



design of pit. The pit is very deep and the flame is generated over the top of the ingots. Square pits are bottom fired vertically at the center of the pit by single jet, steam atomized oil burners. Fuel oil used per hole will range from 75 to 150 gallons maximum per hour, depending on the size of the pit.

Slab heating—The application of water cooled, single jet steam oil burners on a regenerative slab heating furnace for plate mills is shown in Figure 3. Maximum gallons of oil burned per hour is 180. The furnace is roof fired by three burners at each end directly over the bridge wall. Hearth dimensions are 10 x 40 ft with two-pass checkers, forced and induced draft, and with complete automatic combustion control from furnace temperature, including automatic dampering. Figure 4 shows the oil control for one of these furnaces. Note the integrating meter, oil flow area meter, the differential static converter and the oil flow control valve, all mounted in 3-way plug cock by-pass sections. Figure 5 shows the instrument panel for the furnace. For details of the operation of such a furnace see the author's paper, "Plate Mill Heating Furnaces," 1944 Yearbook, Association of Iron and Steel Engineers.

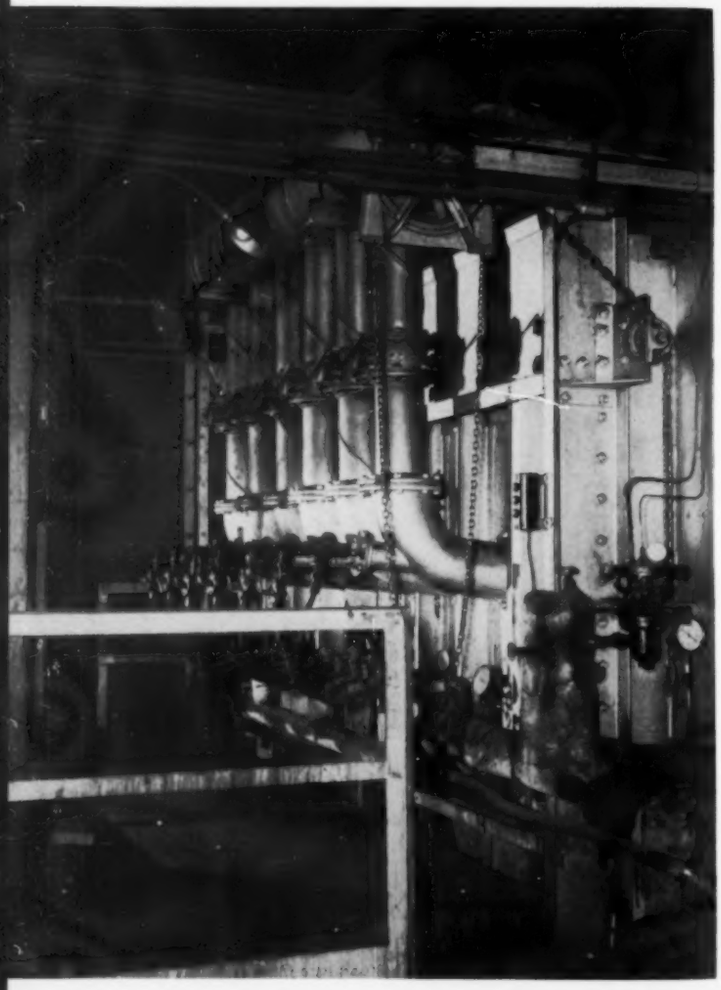


Figure 22 — Illustrated here is the first zone firing of a two-zone alloy steel billet heating furnace.

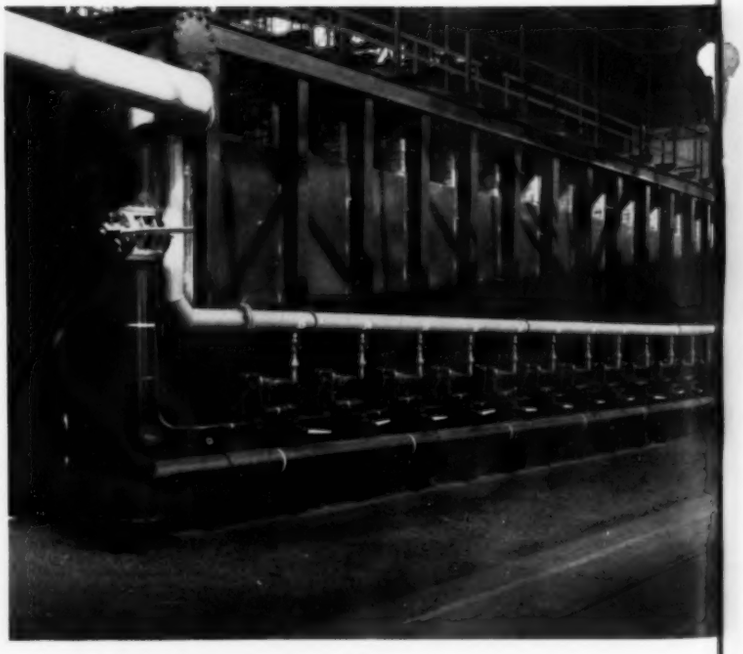
Small billet heating furnace—The oil and coke oven gas application of a 25 x 30 ft billet heating furnace in a continuous rod mill is shown in Figure 6. Twenty-six burners are fed by two steam oil mixers in parallel, each having thirteen outlets. The oil flow control is shown in Figure 7, and the instrument panel in Figure 8. Maximum gallons per hour is 390. This is a recuperator type furnace with complete combustion control from furnace temperature.

Figure 23 — A battery of twenty-nine furnaces are used for heat treating forging.

Large billet heating furnace—Figure 9 shows the application of coke oven gas and fuel oil to a 32 x 50 ft billet heating furnace. Twelve burners are fed by a single steam-oil mixer using a maximum of 500 gallons of oil per hour. Figure 10 shows the oil control and Figure 11 the instrument panel for this furnace.

Lap weld skelp reheating furnace—Figure 12 shows the application of coke oven gas and fuel oil to a skelp

Figure 24 — Fifteen burners are used to fire each side of the furnace shown in Figure 23.



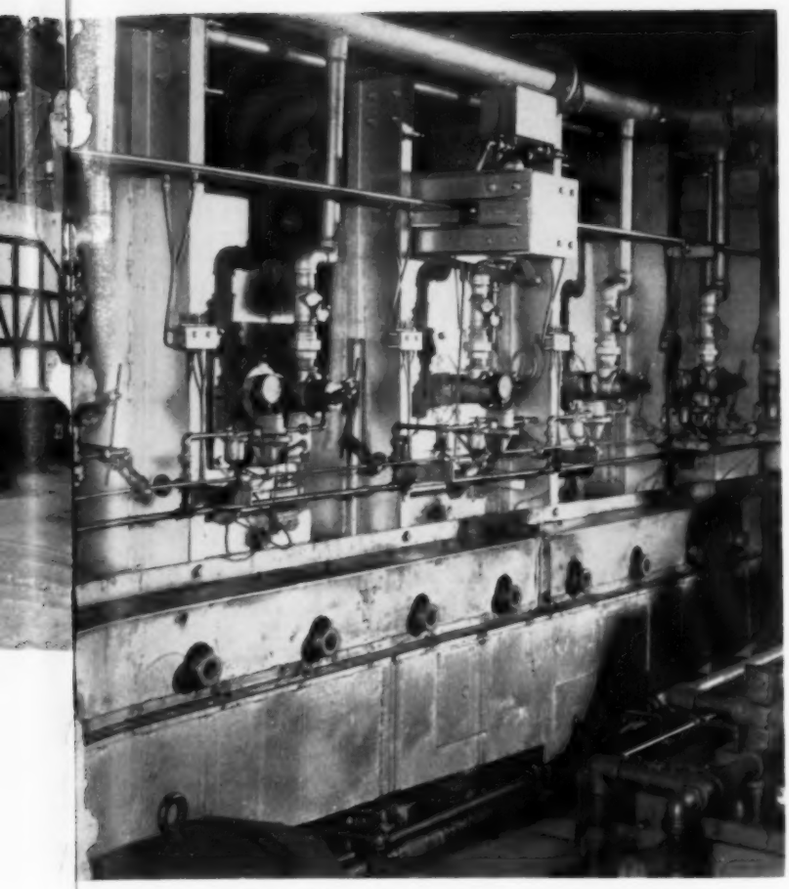


Figure 25 — Side of a continuous roller hearth furnace.

furnace with a hearth dimension of 11½ x 24 ft. The oil is fired above the gas by twenty-three water cooled single jet burners fed by two steam-oil mixers in parallel. This is an automatic reversing two-pass regenerative furnace with complete combustion control from furnace temperature.

Three-zone slab heating furnaces—The application of fuel oil to a three-zone slab heating furnace is partly illustrated by Figure 13, which shows the steam-oil mixer and the oil burners for one zone only. These furnaces are of the recuperative type with complete automatic control from zone temperatures. Each zone is fed by a steam-oil mixer having ten outlets. These furnaces are 24 x 90 ft, burning a maximum of 1150 gallons of oil in each of the three zones. Figure 14 shows the oil flow control units for the three zones. Figure 15 gives the remote actuated furnace pressure and combustion air regulators for one furnace. Figure 16 shows the back part of the instrument panel for the three furnaces and Figure 17 part of the front of the same panel.

A pair of three-zone slab heating furnaces with a different method of firing are shown in Figure 18. These furnaces are equipped to use both gas and oil as a fuel.

Figure 19 gives a closer view of the burners. Note the electrically driven gas and oil valve being operated through mechanical linkages from the control mechanism.

Rod patenting furnace—One of our rod patenting furnaces with a hearth of 5 x 50 ft burns a maximum of 50 gallons of oil by means of six mechanical atomizing, 1½ lb air oil burners. Combustion air is controlled by a diaphragm valve actuated by an air operated potentiometer. The combustion air is measured by a hand-set iris valve to change the ratio of air to oil. The differential across the iris valve is subtracted and multiplied by a differential static converter which actuates a double top oil pressure regulator. This method gives very accurate control of furnace temperature and furnace atmosphere.

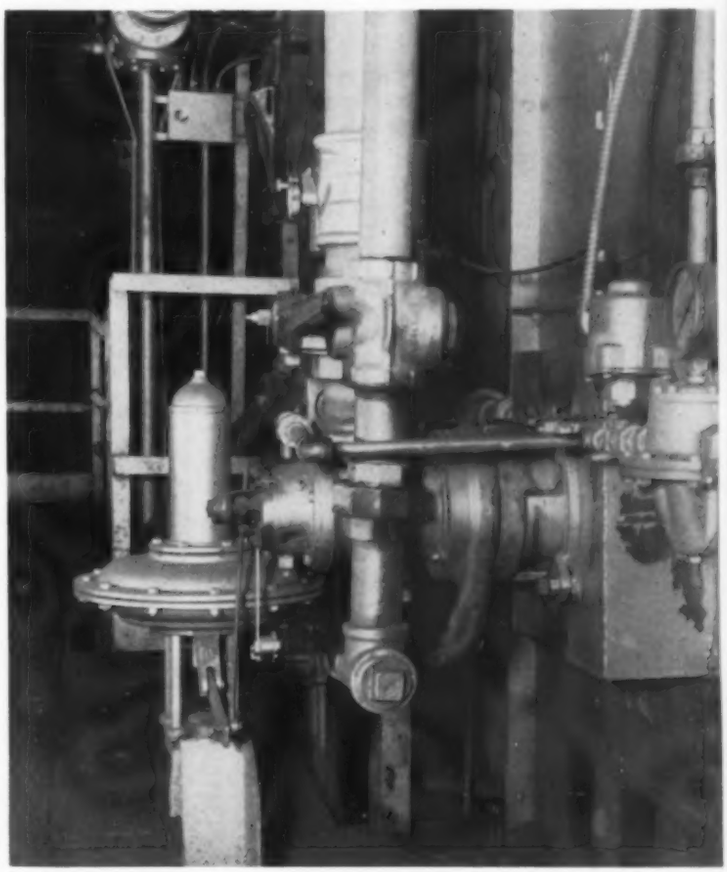
Large forge furnaces—Three large forge heating furnaces, part of a battery of seven, are shown in Figure 20. These furnaces are of the car-bottom type, having a hearth dimension of 16 x 35 ft. They are fired by six combination coke oven gas and oil burners on each side, as shown by Figure 21. Furnace temperature is recorded. Fuel control of both gas and oil is by hand. Maximum gallons of heavy fuel oil burned per hour is 150.

Small forge furnaces—Combination coke oven gas and light fuel oil firing is used for small forge furnaces. In this case, the furnace temperature is recorded, and control of both fuels is by hand. Size of hearth is 8 x 14 ft. Maximum gallons of oil burned per hour is 80.

Small continuous billet heating furnace—Figure 22 shows the first zone firing of a two-zone alloy-steel billet-heating furnace. Fuel is oil only, and is automatically controlled from furnace temperature. Size of furnace is 11 x 39 ft. Maximum gallons of oil per hour is 180.

Forge heat treating furnace—Figure 23 shows two furnaces of a battery of twenty-nine furnaces for heat treating forgings. Fuel is combination blast furnace gas and light fuel oil. These furnaces are of car-bottom type

Figure 26 — A single oil burner is used to fire a large core drying oven.



with hearth dimensions 7½ x 70 ft. Each furnace is fired by fifteen burners on each side, as shown in Figure 24. Furnace temperature is recorded, fuels are hand controlled. These furnaces use a maximum of 120 gallons of light fuel oil per hour each.

Continuous heat treating furnace—Figure 25 shows the side of a continuous roller hearth furnace. This furnace is fired with light fuel oil using 1½ lb air for atomization. The burners operate in parallel by means of mechanical linkages from furnace temperature. Size of hearth is 6.5 x 26 ft. Maximum gallons of oil per hour is 50, passed through a total of eight burners.

Core drying ovens — Figure 26 shows a single oil burner firing a large core drying oven. The burner is operated by a diaphragm motor through a mechanical linkage. The size of the hearth is 10.6 x 30 ft. A maximum of 15 gallons of oil is burned per hour.

CONCLUSION

One of the most important duties of a steel plant engineer is to keep his plant designed according to the economic trends of the times. He must be a past master in the art of providing plant flexibility. He must never allow himself to be static. Instead, he must be mentally alert at all times.

Never before in the history of our country have the changing costs and availability of raw materials moved so fast in relation to time. This is especially true in the case of fuels, particularly fuel oil.

That there is and will continue to be a scarcity of heavy fuel oil is a fact that must be acknowledged. Scarcity and price will change many industries back to coal or fuels produced from coal. The steel industry will surely be one of them.

Steel plant fuel engineers can and will effectively cope with the situation. There are many new ways of applying the substitute fuels. Greater utilization of coke oven and blast furnace gas can be made by increasing the thermal efficiency at each individual application wherever possible, by scheduling mills to avoid bleeding these gases, and by the use of gas holders. Oil can be replaced in boilers by means of the chain grate stoker for coke breeze and the pulverizer for coals. Coke oven gas can be used in the open hearths in substantial quantities in combination with coke oven tars or topped tars. A synthetic gas from coal to match coke oven gas can be made and used to fill out the plant fuel balance requirements.

Fuel oil can and will be replaced if and when necessary. The issues are clear, the lines have been drawn. Time will be the referee.

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DISCUSSION

PRESENTED BY

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J. B. WAGSTAFF, Hydrocarbon Research Co., New York, N. Y.

PROFESSOR W. TRINKS, Associated Engineers, Pittsburgh, Pa.

H. H. SEABROOK, JR., Peabody Engineering Corp., New York, N. Y.

HAROLD V. FLAGG, Combustion Engineer, Armco Steel Corp., Middletown, Ohio

A. J. FISHER, Assistant Chief Engineer of Construction, Bethlehem Steel Co., Bethlehem, Pa.

Martin J. Conway: In attempting to discuss Mr. Fisher's paper briefly, I believe I can best do so by dividing my remarks to apply to the two broad divisions of the paper: first, prophecy on the future trends of fuel processing; and second, subsequent utilization.

It is true that we are running out of oil, but we are also running out of iron ore and out of coal. Or are we? It is also true that we are using all of these materials in unprecedented quantities, with little possibility of reduction. Some years ago I heard Dr. Egloff of U.O.P. make a statement that our grandchildren's grandchildren still would be using oil. That statement was made some fifteen years ago, to assuage the grief over our then waning petroleum reserves, which are now greater than they were at the time Dr. Egloff made that statement. However, with the now known possibilities of production of oil and gas from coal by synthesis, it is purely a matter of economics in determining the switch from natural to synthetic, independent of the comparative shortage of either fuel. Fuel costs per unit of production will, therefore, be the deciding factor in the type of fuel used in the future as in the past.

I am interested in the author's statement: "Inasmuch as 65 per cent of the fuel oil used in the steel industry is for open hearth furnaces, oil companies could certainly enhance a sizable portion of their product by making an open hearth fuel oil." Whatever this amount may be, I for one, do not propose to provide the oil companies with an excuse to charge a premium over the present price of fuel oil.

By making deductions for a reasonable amount of freight and handling, this residual oil, in some cases, now costs more than a good grade of gasoline fob refinery, and proportionately with other fuel cost increases, it is certainly out of bounds.

Crude oil characteristics and basic refining practices will account for differences in residual viscosity which cannot readily be made uniform. Sulphur content control is an individual plant problem. Economic use of processed gas in the steel industry, whether by switching or mixing, is of course an aid to low fuel cost in steel plants which also have coke plants and blast furnaces.

Many steel plants start their operations with the open hearth and must resort to the use of residual fuel oil or coal processed to yield usable heat at the port of the furnace at the lowest cost. These latter plants do not have topped tars, coke oven tars, and other sources of fuel available to the integrated steel plants, but I feel pretty sure that their engineers will do a real fuel application job, which Mr. Fisher, because of the broad scope of his picture, could not entirely cover.

I would like to have Mr. Fisher tell us the viscosity at 122 F of the topped tar he refers to using.

J. B. Wagstaff: I noticed that Mr. Fisher implied the close relation between the oil industry and the steel industry. We find that when the oil industry produced fuels cheaply, then the steel industry very rapidly developed means of using those and found that oil fuel in the open hearth was a very easy fuel to use.

Now we find that the transportation industries are using more and more of the petroleum materials, and it is probably true that the transportation industries will always be able to pay higher prices than other industries for petroleum products.

Furthermore, the developments in the oil industry are such that a larger and larger proportion of the crude oil can now be converted into products suitable for the transportation industries, leaving less and less for the "stationary" industries.

That then puts the steel industry in the future into difficulties, but it is interesting to note that at least one solution to this problem is coming from the oil industry itself. Due to the development of synthetic gasoline from natural gas in this country and from coal abroad, we find the development of gasification processes on a scale hitherto not imagined. I refer to the possibility of gasifying 1000 tons of coal a day in one gas generator. This gas generator would normally make gas of about 300 Btu per cu ft, but again, thanks to the oil industry, it is now possible to convert that gas quite cheaply into another gas of calorific value of about 600 Btu per cu ft. This then gives us a complete gasification process from coal to gas of about 600 Btu per cu ft, and in this process it is possible again with reasonable cost to remove sulphur from the fuel. So we can consider the possibility of using some of these coals now fairly cheap, containing three or more per cent sulphur and turning those into a fuel of 600 Btu per cu ft, sensibly free from sulphur which is quite suitable for firing even in the open hearth.

It is not yet certain how such a gas can be used to eliminate oil completely in the open hearth but there is no doubt that new methods will be developed in the future as the necessity arises.

We know that in this gasification process we also make an appreciable proportion of tar, although the tar is not as suitable a basis for the ordinary chemical industry as coke oven tar. This tar will be available for combustion in the open hearth and should provide a very useful illuminant. It, therefore, seems that the oil industry, while presenting one problem of making petroleum oils rather more expensive, may also provide us with the solution by showing us how to make gas on a large scale economically.

W. W. Trinks: In a steel plant near Lake Michigan there is a big heating furnace which is fired with oil, and it has a metallic recuperator. A brownish dust, which sticks closer than an adhesive plaster, is deposited on the metallic surfaces of the recuperator. I wonder whether Mr. Fisher has had a similar experience and can tell where that is coming from?

H. H. Seabrook, Jr.: I would like to ask Mr. Fisher if the steel industry is in need of an improved combination burner to fire various furnaces with oil or gas? With the present oil shortage and consequently high cost, available gas would supplement oil where possible.

Harold Flagg: I was interested to hear Mr. Fisher raise the question of mixing powdered coal with fuel oil, since this data has interesting possibilities in the face of fuel oil shortage. Our own experiments on oil-coal mixtures several years ago brought out some interesting information concerning this fuel with regard to utilization, limitations, and performance. Serious shortcomings in our mixing plant made it necessary to discontinue experimental work until such time as extensive changes in the plant shall be made.

A. J. Fisher: Mr. Conway asked about the viscosity of tar. We do not know what it is. It is too heavy to run at 122 F. There is certainly no doubt about the use of tar as a preferred fuel in the open hearth, and in addition to that, top tar or pitch is still a better fuel than tar. We have found that because of the competition of other industries outbidding us for fuel oil, that we are forced more and more to use lighter fuel oils to keep going, and in many cases we have used oils in open hearth furnaces of 14 viscosity which is very little more than colored kerosene.

First of all, we would like to have a stabilized oil at any viscosity. Second, we would like to have a stabilized oil at, say, a high viscosity. Then as a still better fuel we would like to have tar, and pitch. Now if by mixing coal and oil or carbon and oil we could stabilize the luminosity value of oil at some fixed value, like heavy oil, or tar, or pitch. We would have a preferred open hearth fuel.

Professor Trinks asked about sticky dust on recuperators in oil firing. There is no question but that this problem is coming from the low fusion point ash in the fuel oil.

Mr. Seabrook has asked about varying oil viscosities. These oils of varying viscosities come to us in tanker lots of approximately 100,000 barrels at our Sparrows Point plant. Each tanker carries a different grade of oil. We have received all possible combinations of gravities and viscosities.

He also asked about combination oil and gas burners. We at Bethlehem have been doing a lot of work in respect to open hearth firing of gas and oil. Oil and gas burners, in various metallurgical and heating furnaces, boilers, etc., are not a problem with us. The only problem is in the open hearth. That is where 65 per cent of the oil is. We are still looking for the fellow that has a good oil and gas burner for open hearth use.

Practical Approach

. . . . to be effective, safety must be practical . . . . this cannot be successfully accomplished from an ivory tower, but must be done on the job by qualified men . . . .

▲ THOROUGH safety inspection by qualified inspectors is important in any safety program. The safety inspector should have full authority to shut down any equipment which he considers dangerous. Nothing will break down the safety morale of a plant quicker than the remark, "Well, the safety inspector is all right, but he does not have authority." Once full authority is given, the inspector must respond by doing everything possible to keep production running on a safe basis. When machinery is shut down because it is unsafe, it is the responsibility of the safety inspector to assist in getting it running again. For example, temporary wooden guards can be quickly knocked together to cover the hazard until sketches are made and a metal guard installed. A safety inspector should be specific in his decisions and not leave supervision in doubt as to what should be done.

The most successful inspector is the one who helps to get corrections made once unsafe conditions are found. It is easy to find things wrong and write them up, but the biggest job is to have them corrected and at the same time keep production running.

To sum it up, safety inspections must be thorough, practical, and a help instead of hindrance to the operation of the plant. The inspector must get action and build up a reputation for being practical and getting things done.

Guarding equipment—Many safety problems can be quickly solved if equipment is guarded mechanically and the machine made as fool-proof as possible. Experience proves that the complete covering of all moving parts of a machine up to the point of operation is a good investment. It is important to set up a system whereby new machinery cannot be run until released by the safety department. An installation order, showing approximate date of delivery, plant, location, and type of machine is sent to the safety office. The inspector then checks it as it is delivered and sees that every safety specification is met before the machine goes into production.

Safety engineering control—Safety engineering control demands patience, planning and cooperation with all the departments in a plant. To avoid serious accidents the following suggested plan can be very helpful:

1. Check and sign all requests sent to the purchasing department for safety equipment such as respirators, goggles, face shields, and all types of safety clothing.
2. Institute a system whereby all engineering layouts, new buildings, alterations to old buildings, or any important change within the plant are signed by the safety department.
3. The purchasing or engineering department should get the safety department's approval on all new machinery, cranes, elevators, mechanical trucks of all kinds and similar equipment. The setting up of safety standards on equipment of this kind before it is bought will eliminate many complications and accidents at a later date.
4. Strict control over the use of all inflammable materials such as gasoline and paint thinner as well as all toxic materials.
5. Yearly examinations of truck drivers, crane operators, elevator operators, hookers, riggers, welders, floor truck operators and all men who climb above the floor level. Physical examination for heart, eyesight, blood pressure, hearing, and ability to distinguish color. Safety examinations in rules governing his job. If he passes both examinations, the operator winds up with a safety permit and a copy of the rules. The permit is signed by the safety department and is good for one year.

Education and training—The best training any employee can get is at the machine. Additional programs are very useful, such as safety posters, moving pictures, supervisors' safety conferences and the safety engineer meeting with key executives. However meetings can be overdone, and in some instances too many safety problems are settled in air-conditioned offices or committee rooms instead of at the point of danger in the shop. I checked a number of men individually to see what made the most impression on them, and in every case they preferred the training on the job.

The practical approach to the safety engineering problem is by thorough and practical safety inspection. Complete mechanical guarding of equipment, safety engineering control in all phases of purchasing, engineering, and production, and finally a sound educational program with special emphasis on training the operator on the job should be the policy of every safety department.

The human side of safety—Generally speaking, after we have set up:

1. Safety engineering standards,
2. Mechanical guarding,
3. Instituted thorough inspection,

and numerous other activities which go to make modern production safe, we find ourselves face to face with a problem which has puzzled mankind for centuries—"The Human Side of Safety."

There is only one way the safety director can fully appreciate the human side of the job, and that is to stand at the point of operation, see how it functions, and not only see, but feel what it is like to be at that one spot eight hours a day.

Let me classify some of the things that exasperate the men on the job:

1. Poor lighting.
2. Unnecessary handling of stock.
3. Faulty machinery.
4. Failure to respect his suggestions.
5. Failure to get his side of the story.

One could go into many examples, but time does not permit. The human side of the employee in the safety field can be summarized as follows:

1. Try to understand his difficulties.
2. Let him know he is a part of the safety program, and a very important part.
3. Encourage him to tell you what is wrong.
4. Make definitely sure he is not afraid of the job.

Presented before AISE Detroit District Section Meeting, January 11, 1949

to Safety Engineering

By WILLIAM S. SMITH
Director of Safety
Ford Motor Co.
Dearborn, Mich.

5. If a man is injured, remember his statement is more important than all the others put together. The human side of the case lies clearly in the fact that *he was the one who was injured.*

The manager—There is no necessity of having to "sell a manager on safety." All managers want their plant to operate safely. I never met a plant manager, and I have met a lot of them, who wants accidents. The important thing for the safety engineer to remember is that the manager is running the place and he has many problems on his mind.

Therefore, be practical and businesslike in your approach. Here are a few suggestions:

1. Choose the right time to discuss safety problems.
2. Do not lose contact by allowing too long a time between your meetings.
3. Prevail upon him to go with you and see the hazards in the noise, smoke and heat of factory life. Do not look at the safety problem through a telescope from a long range office. During the war I was on an advisory board and saw a lot of THAT kind of engineering.
4. Everybody likes to tell the manager that the accident was caused by "the dumb, dizzy way the man did the job." Avoid this as you would the plague. Very often it is the best men who are injured, and more often still, it is the fault of the safety director that the job is running in the manner that caused the accident. A manager is human and wants to know the facts.
5. It is only human for him to be interested in cutting costs and increasing production. Let him see where a safety device is doing this and there are many in every plant.
6. Do not get him confused with too much paper safety. Periodic study together with shop conditions are a necessary part of human understanding.

Putting it all together, "The Practical Approach to the Safety Engineering Problem" calls for a sympathetic understanding of what the employee goes through at the machine, supervision's problem of getting production, and the manager's responsibility in making the place pay. Many accidents in the future will be prevented by good teamwork along this line.

HOW DO MEN GET KILLED?

After all our study of inspection, procedure, codes, equipment and training, the very essence of the whole problem is "How Do Men Get Killed?" Here are a few examples from a national survey of various corporations.

Welder—A welder placed a small job on an empty drum. At lunch time he shut off his torch and hung it in the bung-hole of the drum. Thirty minutes later he lit the torch and the drum exploded, killing him. Leaking acetylene turned the drum into a bomb.

LESSON: Never use a welding torch where acetylene fumes can collect in an enclosed space.

. . 440 Volts—A new shipping dock was built alongside a building. Everything was ready to run except the conduit to enclose the 440 wiring. It was decided to run it for a short trial. The bare cable rubbing on the steel created a contact and electrocuted the millwright.

LESSON: Complete safety equipment before starting operations.

Salvage pipe—A company bought some salvage pipe to use on a low pressure line. A father and son were given the job to weld a fixture on it for a pressure gage. When the torch cut through the pipe, the father and son were killed. Investigation revealed that the pipe had come from a war plant, manufacturing gun powder.

LESSON: Find out where salvage material comes from, and above all, thoroughly purge pipes or tanks and take explosion readings before cutting or welding.

Cleaning—A cleaner entered a fan casing to clean paint residue. He started the job with gasoline and a defective portable light. A spark and the gasoline flashed and burned him to death.

LESSON: Never use inflammable liquid for cleaning and where necessary use a vapor-proof light.

Cranes—An engineer climbed onto a steel plate between the building trusses and crane rail to study a new layout. The crane came along and crushed him to death.

LESSON: Notify crane foreman, crane operator and place temporary safety bumpers before anyone is allowed on crane rails.

Shot blast machine—Following the repair of a large shot blast machine everyone thought it was ready to run. After lunch it was started up, and among the stock they found parts of a man. This turned out to be the repairman who apparently decided to make a final check.

LESSON: Lock the main switch and make sure the key is in the repairman's pocket and nowhere else.

Floor trucks—An employee operating a power-driven truck approached an elevator, forgot how to stop, went through the gate, fell five floors to the elevator pit and was killed.

LESSON: Floor truck operators should be given the same strict safety examination as the driver of any other truck and particularly warned to pull up at an elevator facing at an angle away from the elevator gate.

Crane operators—A crane load was left a few feet from the floor while the operator was out of the cab. The operator of No. 2 crane bumped it to make more room for his particular load. Uncontrolled, crane No. 1 drifted and killed a man between the load and a wall.

LESSON: Never permit operators to bump cranes. All crane operations should be under the direct control of a hooker.

Electricians—A veteran who went through four invasions without bodily harm was working on electrical work when he was electrocuted. He was young and newly demobilized.

LESSON: Always cut off the source of power and lock it. Make sure that helpers on dangerous work of this kind are properly instructed and in the hands of experienced men.

Improved Flying Shear Drive

. . . . a new flying shear uses a single motor, located in the motor room and directly connected to the shear, which should thus eliminate some of the usual maintenance problems . . . .

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▲ AS part of the output from a hot strip mill is sold as hot rolled sheets or further processed in sheet rather than coil form, many of these mills have a flying shear immediately following the final finishing stand. This shear cuts the strip, as it emerges from the final finishing stand, into approximately the correct length or some multiple of that length. These sheets are then piled further down the mill.

If the length of the sheet being cut is to be maintained with any degree of accuracy it is immediately apparent that the shear must be synchronized with the mill. This synchronization can and has been obtained in several ways: a mechanical drive connecting the shear and the last stand together, a hydraulic tie connecting the two drives, and an all-electric drive, to mention only the more common methods employed.

It is current practice, in general, for a hot strip mill to have a delivery speed range of at least 2 to 1. In order to obtain the desired sheet lengths or multiples of that length, the range of cut length must also be at least 2 to 1. Since these two factors are cumulative, the shear must synchronize with the mill over a range usually in excess of 4 to 1.

If it were possible to continuously cast the steel prior to rolling in the hot strip mill so that its output would, in turn, be continuous, the principal problem in building a good flying shear drive would only be that of synchronization with the mill. However, since this is not yet the case, in order to reduce the scrap and therefore increase the yield of the mill it is necessary that the shear be stopped after each piece and restarted for each succeeding piece.

We would now like to point out what we believe to be the fundamental requirements of a good flying shear drive. First, it should be relatively simple with a resulting low cost of maintenance. Second, it should be sufficiently stiff to provide good synchronization with the mill. Third, it should be infinitely variable in speed so as to completely cover the normal operating range. Fourth, it should be readily adjustable so as to minimize the time required to change from one length of cut to the next. Last, but not necessarily least, it must be reliable since a failure to operate at any time could result in a cobble with subsequent damage to the mill.

A mechanical tie, in the light of these requirements, falls short of the ideal in that if it is to be stiff it is likely to be cumbersome. If it is to be variable over much of a range it becomes rather complex with correspondingly increased maintenance. When it becomes complex, it is not likely to be easily changed from one length of cut to another.

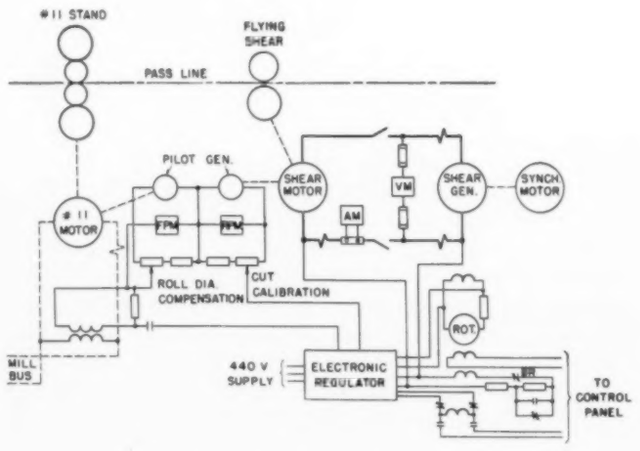
Similarly, the hydraulic tie is not simple as it consists of two hydraulic motors with the necessary valves and accessories for providing variable speed. It can only be kept stiff by rather costly maintenance. It is also not readily adjustable from one sheet length to another.

Having these requirements in mind, the flying shear drive which will be discussed in this paper was designed. Figure 1 is a simple schematic diagram of the drive. It consists of a single motor which is direct connected to the bottom knife of the flying shear, an adjustable voltage d-c generator driven by a synchronous motor, a rotating regulator, an electronic regulator, and two pilot generators.

It was observed that most of the flying shears now in operation were unable to stop after cutting a piece to length, reset, and then restart in time to crop the front end of the succeeding piece; especially when the succeeding piece was entering the first finishing stand as the preceding piece was leaving the final stand. Consequently, it was found to be the practice in many mills, under such rolling conditions, to simply let the shear run with the result that the first length cut from each succeeding piece might vary from almost nothing to 95 per cent of the desired length. This, of course, was scrap and reduced the yield of the mill.

It is a well known fact that when the shear is making the cut, its speed drops due to the cutting effort. The amount of this impact drop and the time required to

Figure 1 — Schematic sketch of flying shear.



Presented before AISE Annual Convention, Cleveland, Ohio, September 29, 1948.

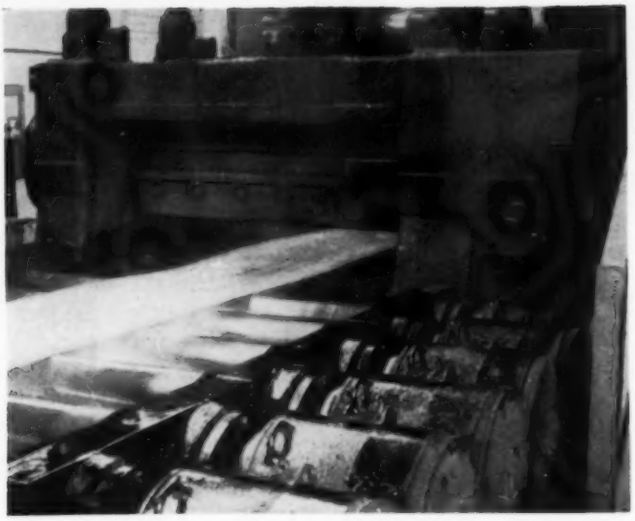


Figure 2 — Delivery side of flying shear.

recover from it largely determine the accuracy which can be obtained.

In choosing the driving motor for this application the first thought is that it should be low in inertia so that the acceleration will be fast. On the other hand, however, a low inertia drive is apt to have a greater impact drop; and even though the recovery time is less, the overall error may be greater than that resulting from the use of a drive of higher inertia with greater recovery time.

In studying this application it was found that with several possible combinations of motors, the inertia of the shear itself was from 85 to 90 per cent of the total inertia of the drive. Figure 2 shows the shear from the delivery side. It is therefore apparent that little can be done from the electrical standpoint in changing the inertia of the system. This is not necessarily as great a handicap as it might appear, since, as was previously mentioned, the impact drop will be inversely proportional to the inertia of the system. In order that the acceleration be fast and that the time required to recover the impact drop be held to a minimum, it was therefore necessary to provide sufficient peak torque capacity in the motor to handle this inertia. It was found that this could best be done in the single motor, as used, rather than in two motors geared to the shear as have formerly been used.

With this arrangement at least three of the fundamental requirements have been met. A single motor

Figure 3 — The motor operating the lower blade is located in the motor room.

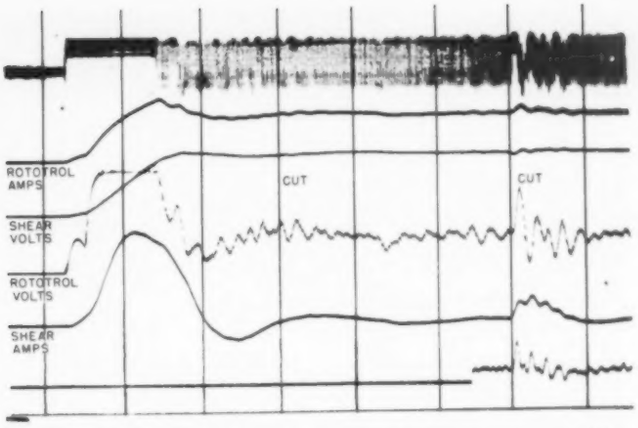


Figure 4 — The armature current shown on the oscillogram is a direct indication of the available torque.

direct-connected to the bottom knife eliminates all gearing except that between the upper and lower shear knives. This lack of gearing readily permits the shear motor to be located in the motor room rather than crowded into an already cramped space near the last finishing stand pinion. Locating the motor in the motor room, which is much cleaner, plus the fact that it is a rugged, heavy duty, type of motor should combine to materially reduce the electrical maintenance required and increase its reliability. Eliminating any gearing between the motor and the shear has increased its simplicity with correspondingly decreased mechanical maintenance. Increasing the peak torque available has increased the stiffness of the drive. Figure 3 shows the motor used with the final finishing stand motor in the background.

This stiffness can best be seen from an oscillogram, Figure 4, which was taken on this shear drive. From this it can be seen that the shear bus current reaches a maximum in approximately one-half second. The torque of a motor is equal to a constant of the design times the product of the field flux and the armature flux. Since for this application the field flux of the motor is held constant, the armature current is therefore a direct indication of the available torque. Because of this high torque the shear drive is able to follow the shear voltage which is forced up to the desired value in practically a straight line. This means that the shear can be accelerated to the proper speed in approximately three-quarters of a second. Similarly it can be stopped in approximately three-quarters of a second.

Figure 5 — By simplifying the control of the flying shear maintenance has also been reduced.

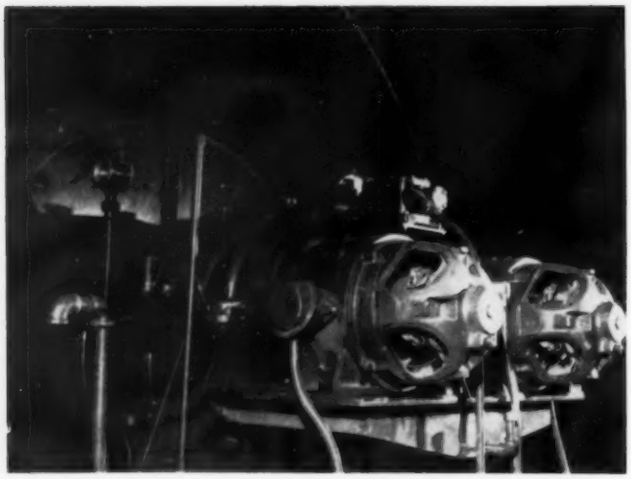


Figure 6 — The pilot generators were designed to minimize variations in their characteristics.

It should be noted here that the shear was definitely up to speed before the first cut was made. It was found, from these tests, that the impact drop for this and each succeeding cut was approximately 4 per cent or less which was recovered in two-tenths of a second or less.

As it is impossible to accelerate a drive of this sort in zero time, it becomes necessary to initiate the starting from some point back in the finishing mill train. For this particular flying shear the starting is initiated by a load relay on the next to the last finishing stand. It is believed that this is one stand later than is common practice for flying shears of this type and this was made possible by the decreased time required for acceleration. This increases the front end cropping accuracy of the shear because there is less opportunity for a change in the speed of the strip to occur between the initiating of the starting of the shear and the actual cut. Being able to initiate the starting of the shear from later in the mill permits more time to stop the shear, reset it, and restart in order to crop the succeeding piece. This, combined with the faster starting and stopping, has made it possible to stop and restart this shear between successive pieces under any rolling conditions which we have observed.

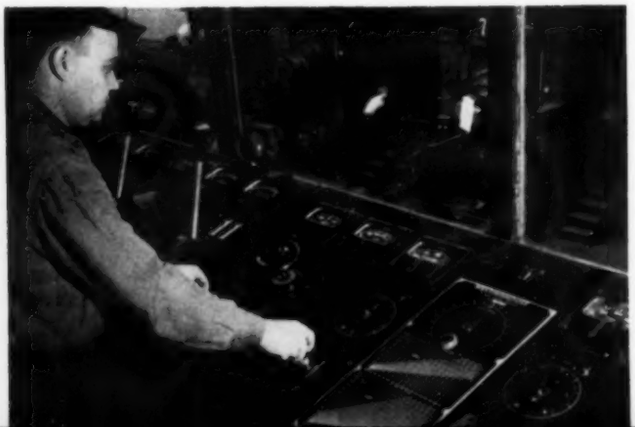
Possibly at this point it might be well to explain what is meant by resetting the shear. If the shear were permitted to stop wherever the limit switch stopped it and subsequently restart from that point, a cumulative error would result unless the drive always stopped at exactly the same point. Due to friction, heating, and other variables it is impossible to stop at exactly the same point. Hence, a flying shear drive of this type, in stopping, is slowed down to a low creeping speed and then stopped. On most shears it has been observed, however, that the drive overruns the final limit switch and has to reverse and creep back to the final stop. With the high peak torque available in this drive, it is possible to bring the shear to the creeping speed and stop at the final stop, thus eliminating the necessity for reversing the drive, resulting in an appreciable reduction in the time required to reset the shear.

Another of the fundamental requirements, that of being infinitely variable, has been met through the use of an adjustable voltage drive. This, in itself, is not new to this application, but it may be well to point out, in passing, that the control has been simplified to such an extent that only a 32 in. wide factory assembled panel is required. Figure 5 shows this control at the left with the electronic regulator mounted in the rear framework, the adjustable voltage motor-generator set at the right, the rotating regulator in the center, and the shear motor in the background. When it is recalled that a panel approximately 120 in. wide has formerly been used for these flying shears it is at once apparent that much progress has been made in simplifying the control which should result in greatly decreased electrical maintenance with correspondingly improved reliability.

Referring again to Figure 1, we would like, at this point, to describe the operation of this control. The intelligence for synchronizing the speed of the shear with that of the final finishing stand is provided by the two pilot generators, one geared to the shear motor and the other to the final finishing stand motor. The voltage output of these pilot generators is connected so that they are in opposition to each other. Consequently, the two drives are in exact synchronism when the differential voltage is zero. Suitable potentiometer rheostats have been provided to recalibrate the output voltage of these pilot generators for the various diameter of rolls which may be employed in the final finishing stand and to fully cover the desired range of cut lengths. The differential voltage output of the pilot generators is fed into both the rotating and the electronic regulators which combine to control the rates of acceleration and retardation and to keep the shear in synchronization with the mill. With the two regula-

Figure 7 — The electronic regulator is a factory assembled unit.

Figure 8 — All controls are conveniently located at the control desk.



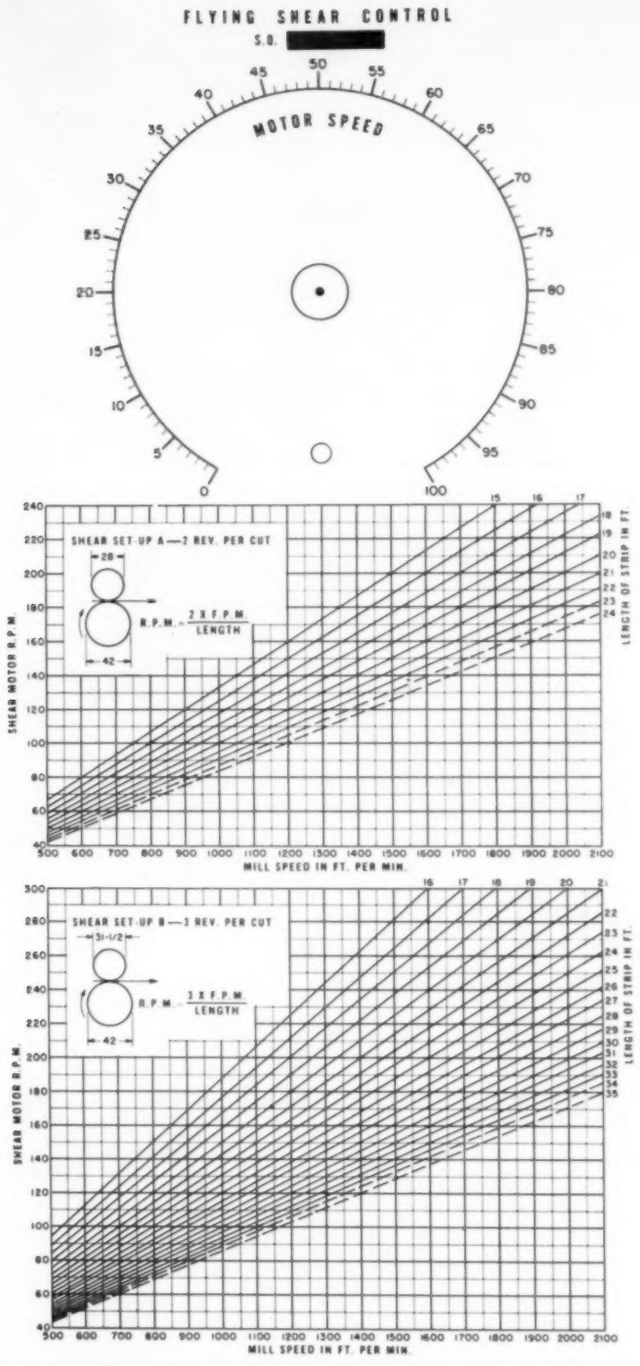

FLYING SHEAR CONTROL
S.D.
MOTOR SPEED
SHEAR SET-UP A—2 REV. PER CUT
R.P.M. = 2 X F.P.M. / LENGTH
SHEAR MOTOR R.P.M.
LENGTH OF STRIP IN FT.
MILL SPEED IN FT. PER MIN.
SHEAR SET-UP B—3 REV. PER CUT
R.P.M. = 3 X F.P.M. / LENGTH
SHEAR MOTOR R.P.M.
LENGTH OF STRIP IN FT.
MILL SPEED IN FT. PER MIN.

Figure 9 — A convenient nomograph on the control desk is used to establish the speed of the shear motor.

tors, it is possible to employ current limit control to protect the equipment from excessive peaks while at the same time using all of the forcing permissible and also to obtain an excellent degree of synchronization during normal operation.

As no control system can be better than the intelligence which it receives, considerable care was exercised in the design of the pilot generators to either entirely eliminate or greatly minimize any variations in their characteristics which would adversely affect the overall operation of this drive. Figure 6 shows a close-up of the pilot generator mounted on the front pedestal bearing of the final finishing stand motor. A similar machine beside it is used for the adjustable voltage control of the runout tables and coilers.

The electronic regulator, shown in Figure 7 was mounted in the angle iron framework of the factory assembled frame. In order to meet the fundamental requirement of reliability and to insure good life, all of the component parts of this regulator are operated at very conservative ratings. Furthermore, the control is so arranged that in the event the regulator should fail the drive will continue to operate with only slightly impaired accuracy.

Figure 8 is a photograph of the control desk for operating this shear drive. All of the control for the flying shear as well as some of the runout table control is located on this desk. Both the roll diameter compensating and the cut to length potentiometer rheostats are located in front of the operator. In order to change from one cut length to another, it is only necessary for the operator to read the mill feet per minute from the meter on the desk and then from the nameplate, Figure 9, also on the desk, adjust the speed of the shear motor to the proper speed. It may be necessary, in some cases, to make some vernier adjustment after the length has been checked at the piler due possibly to some inability to interpolate from this chart when making the initial setting.

In conclusion, it is believed that this is an improved flying shear drive which meets all of the fundamental requirements: simplicity, good synchronization, variable speed throughout the operating range, readily adjustable, and reliable.

DISCUSSION

PRESENTED BY

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J. RAYMOND ERBE, Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

H. E. Larson: Our company has built or has on order a total of eleven drives which employ the rotating-regulator-electronic synchronizing system. Six of these involve new equipment throughout, five involve only new rotating-regulator-electronic synchronizing controls, using existing motors and motor generating sets. Eight systems are in operation. With this background of experience, I would like to comment on and, in some cases emphasize, the principal points of the paper as well as add a few points of my own.

The first point relates to the use of single direct connected shear motor located in the motor room, instead of a pair of motors geared to and located with the shear.

The appealing advantages of the elimination of gearing and the cleanliness of the motor room location have been fully described in the paper. Offsetting considerations are as follows:

1. The 30 to 40 ft long shaft with bearings necessary to couple the motor in the motor room to the shear presents a consideration of cost and maintenance.

2. A specially designed high torque, self-ventilated motor such as described requires its own spares, whereas the two 150-hp, 450-rpm, 230-volt mill motors that are commonly used are duplicated many times in an average sheet and tin mill.

The next point relates to compactness of controls. Mr. Erbe states that only 32 in. of length are required for the control panel structure. His figures show this to be a double row structure. Rotating-regulator-electronic control also can be built in comparably sized double row structures, although they have been built mostly in single row structures to fit spaces dictated by purchaser's line-up requirements.

The next point has to do with shearing speeds and performance of present drives. The drive described, quoting from the paper: "can be accelerated to the proper speed in approximately three-quarters of a second." Just what is meant by "proper speed" has a very important bearing on the maximum torque that should be built into the drive.

By and large, hot strip mills can deliver at maximum speeds of about 2100 fpm, some more, some less. The usual shearing length ranges from 15 to 30 ft. Our experience has shown that no mill can shear 15 ft pieces at 2100 fpm; 1100 to 1200 fpm is the usual speed. Pieces 30 ft long can be sheared at 1500 to 1600 fpm. These strip speed limitations are not due to the time required to accelerate or decelerate the shear. They are due, rather, to the inability to keep the sheared pieces in line on the runout table at the higher speeds. It is also pertinent to note that drum peripheral speeds, when making 15 ft cuts are usually twice the strip speed, but when making 30 ft cuts are usually equal to strip speed.

A present shear drive on an 80-in. hot strip mill gives performance somewhat as indicated in the following:

In the first case, when making 15-ft cuts at 1100 fpm, realizing that the lower drum makes three revolutions between cuts, the performance of present shear drives is such that the shear will be up to speed in about 2.35 revolutions of the bottom drum.

In a similar case, but using 30-ft cuts at 1600 fpm, the bottom drum is up to speed in considerably less, about 1¼ revolutions.

From these two cases it is concluded that the shear is easily up to speed for making the first cut and could be decelerated to rest without reversal, if desired. Also, the requirement of shearing 15-ft pieces at 1100 fpm, and this is important, is almost twice as severe as shearing 30-ft cuts at 1600 fpm. These cases also illustrate why cropping is most expediently done with the shear control set for the longest cut.

The next point relates to the anticipating time of load relay signals. On a mill having 12 ft spacing between the last stand and the shear, 18 ft spacing between finishing stands, and delivering at 1600 fpm, the time required for the metal to travel from next to the last stand to the shear is approximately 1.3 seconds. When shearing 30 ft cuts, the accelerating time is approximately 0.94 seconds. It would seem that the difference of 0.36 seconds should be enough margin to permit using a load relay signal from the next to the last stand for starting acceleration.

However, the time of acceleration of the shear is not the only factor. Relays must operate and large brakes must be released. The brakes require approximately 0.50 seconds to release. The load relay signal from the next to the last stand, therefore, hardly gives sufficient advance notice for starting the shear for the case considered. When shearing 15 ft lengths at 1100 fpm, it is necessary to use the signal from the load relay for the second stand from the last.

The last point has to do with the effect of inertia and stored energy. Mr. Erbe's observation that stored energy is helpful when making a cut, as well as a handicap when accelerating and decelerating, is very pertinent and sometimes an overlooked point. During shearing, a low impact speed drop is desirable since the duty imposed on the speed regulating system is lessened, with consequent improvement in repetitive shearing accuracy.

In this respect, the shears now in operation employing twin geared drive have approximately 20 per cent more energy stored in the rotating parts for a given cutting speed than a direct connected drive.

Since the motor inertia of a flying shear drive is small compared with the shear inertia, increased motor torque yields high return in improved acceleration and deceleration rates. A 20 per cent increase in motor torque may only increase the total inertia four or five per cent. It does not present a very difficult engineering problem, therefore, to increase accelerating and decelerating rates. The answer to the question of how much torque to build into a drive beyond the required minimum of attaining cutting speed at the first cut and decelerating the shear to rest within cut limits stems from considerations of economics rather than motor design.

In conclusion the use of higher motor torque should be resorted to only in the cases where it can be economically justified. If the furnace capacity, runout table design, piler operation, etc., are not limiting items, then, should the shear become the bottleneck of production, higher motor torques rightfully should be employed to decrease the spacing between slabs by increasing accelerating and decelerating rates.

Improvements have been made in the later shear drives by providing more liberal generator capacity. Past experience on some of the modified flying shear drives has demonstrated that the generators have not always been equal to delivering the current for the 300 per cent frequently repeated torque peaks which the mill type motors are capable of delivering.

F. O. Schnure: The shear described by Mr. Erbe is on our 68 in. hot strip mill and has been in operation about six months. The length of cuts, while we have not measured them accurately, appear much more uniform than those from a hydraulic controlled drive on an adjacent mill. The overall operation in fact, presents a distinct improvement.

With respect to the direct motor drive on this shear, which is located in the motor room and connected to the shear by a rather long shaft, versus the conventional two mill type motor drive located in the mill and subject to all the mill scale, water and steam spray peculiar to the location, we believe the former to be far superior from a maintenance view point. While the single motor costs more than the two conventional mill type motors, the elimination of the reduction gears and the advantages mentioned above should go a long way towards equalizing this point.

Water Pollution Control IN THE STEEL INDUSTRY

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and
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. . . . some of the efforts made by the steel industry to reduce stream pollution are described in this paper . . . .

▲ PEOPLE living along the rivers of our country are fast learning that it is both costly and unpleasant to drink out of the same waterways into which they dump their domestic and industrial wastes. These wastes frequently contain compounds which produce decided tastes and odors when treated in municipal water plants. In many cases, the oxygen in streams has been lowered to such an extent that aerobic bacteria have been smothered and the anaerobic type which produce bad odors in the stream would have taken over if the pH had not been lowered by acid mine water and waste pickle liquor from our steel mills. At least some waste acid is needed in our rivers until such time as the oxygen content of the stream is raised by a reduction in the quantity of oxidizable wastes. The presence of free acid inhibits but does not prevent eventual decomposition of these wastes at some point further downstream. This is a complication rather than a solution to the problem for it means that municipalities must keep ahead of industry in any abatement program.

In a study of pollution in the Ohio River basin in 1942, the U. S. Public Health Service reported that 10 per cent of the free acid in the river came from steel plants, 47 per cent from abandoned mines and 43 per cent from active mines. The steel industry operates mines and thus shares responsibility for a part of the acid from the active mines. The elimination of acid from active mines will be a long and perhaps costly process. It is, therefore, necessary that our industry decrease pollution at any point possible along the line.

In discussing pollution problems of the steel industry we must realize that a tremendous amount of work has been done and many papers written on acid mine water, waste pickle liquor, and other wastes from our industry. We will not attempt to minimize the seriousness of these wastes but we shall concentrate on the coke plant effluent because this, in our opinion, is the most serious pollution problem that the industry now faces.

This is evident when we note that the U. S. Public Health Service reported in its 1942 Survey on Ohio River Pollution, that the coking of a ton of coal produced wastes equivalent to a population of 15. Fortunately coke plant operators and builders have reduced this to a fraction of the above and are working to reduce it still further.

In this paper we shall discuss waste products in chronological order, from raw materials preparation to processing of the finished product. Our coke plant works will be amplified to illustrate our methods for effluent definition, presentation of data, and pollution control.

Transportation of coal on the river in dry weather may be a source of pollution due to windage loss. Watering of the coal is not too permanent and adds to transportation costs. Oiling of the coal, especially the fines, would be one way of preventing such losses and pollution as well as beneficiating the coal for coking.

The storage of raw materials at the steel plant should not cause any pollution problems unless they are stored in such a place that surface drainage from the piles goes directly to the river. Such storage is, however, usually in pits from which there is no drainage.

In the preparation of raw materials, ore and flue dust sintering can be eliminated as a source of pollution by the use of an intercepting sump which will remove all but about 50 ppm of the suspended solids. Since the quantity of water used is small, this effluent will not be a serious source of pollution.

This brings us to coal processing at the coke plant where the waste problems are considerably more complex. Large quantities of phenolic and other high B.O.D. wastes from these plants tax the self-purification powers of the river considerably. In addition, the extreme sensitivity of the human palate to the chlorophenol compounds brings considerable public attention to these effluents.

A waste cannot usually be adequately defined at a sewer outfall. We must trace the components of an effluent to their sources, and to do this we must be familiar with some of the basic operations in the plant.

Presented before AISE Pittsburgh District Section Meeting, January 10, 1949

It is not our purpose to tell you how a coke plant is to be operated, yet it is well to consider briefly a flow sheet. See Figure 1. This diagram is not intended to be complete but emphasizes those operations that produce waste.

The heart of the plant is the battery of ovens in which coal is carbonized in the absence of air. Three products result from carbonization: coke, gas, and an aqueous liquor containing heavy tar in suspension and certain ammonia compounds in solution. The gas rises through ascension pipes atop each oven and is collected in a main running the length of the battery. The aqueous liquor is recirculated through the collecting main condensing the heavier tars by some sensible heat and heat of evaporation. The portion evaporated condenses when the gas is cooled in the primary cooler. The tar is separated from the liquor by decantation before recirculation. The hot gas passes through the primary cooler where it is cooled indirectly with water circulated through tubes. Phenol, ammonia, light tar, and most of the water is condensed here and is pumped to decanter tanks. The cooled gas next passes through exhauster engines which serve to pump the gas from the ovens and through the subsequent by-product equipment. After the exhausters, the gas is reheated and passed through precipitators where the remainder of the tar is removed in a strong electrostatic field and pumped to the decantation system. The gas then passes through saturators containing 6 to 12 per cent sulphuric acid where the ammonia and other basic compounds are removed as ammonium and pyridine sulphates. The gas, having been reheated before entering these saturators, evaporates enough water so that all the waste water from the vicinity of this equipment may be pumped back into it and a high acid waste is kept from the sewer.

From the saturators the gas passes through a tower where it is cooled by direct contact with water sprays. As the gas is cooled here, naphthalene and other higher boiling oils and water soluble constituents, such as hydrogen sulphide and hydrogen cyanide and phenol dissolve in the cooling water and are carried away.

The gas then passes through packed towers where it is scrubbed with a cold, high-boiling petroleum oil which absorbs the heavier hydrocarbon oils from the gas. The clean gas is then picked up by booster engines. About 40 per cent of it is used for heating the ovens and the remaining gas sent to the steel plant as fuel.

At the ovens, red hot coke is discharged by rams and taken to a quenching tower in a car where it is cooled quickly by water sprays. The water used for quenching is the waste water from the final cooling tower.

The aqueous liquor from the coal carbonization is collected in a decanting tank where the tar settles to the bottom and is pumped to storage tanks. The liquor, known as ammonia liquor, is then taken to storage tanks from which it is fed to the ammonia recovery system. This system consists of three sections, a "free" ammonia still, a phenol recovery tower, and a "fixed" ammonia still. By the use of direct steam the first, or free section, removes free ammonia, some phenol, and decomposes and removes the more loosely associated ammonium compounds such as carbonate, bicarbonate, cyanide, sulphide, and the polysulphides. These gases are swept from the top of the still and returned to the gas stream. The ammonia liquor is pumped from the bottom of the free still to the dephenolizing tower where about 90 per cent of its phenol is removed by steam. This vapor is passed through caustic soda solution for phenol removal, then through the ammonia liquor and then recirculated. The dephenolized liquor is returned to the fixed leg of the ammonia still where it is mixed with milk of lime, and steam distilled to decompose the ammonium chloride, thiocyanate, ferrocyanide, sulphate, sulphite, thiosulphate and other of the more stable ammonium salts. The gaseous ammonia returns through the free leg to the gas stream and the liquor from the still goes to the sewer.

Now let us consider the light oil system. The enriched wash oil is pumped from the gas scrubbing towers to a still where the light oil is removed from it by direct steam distillation. The hot wash oil is cooled and returned to the scrubbing towers. The light oil and steam from the top of the still are condensed and separated and the water drained to the sewer. The light oil is topped and then washed in an agitator with successive portions of strong sulphuric acid, water, and caustic soda to remove unsaturated compounds. The washed light oil then passes to fractionating equipment where it is separated into pure benzene, toluene, and xylene.

Now let us reconsider the flow diagram from the standpoint of waste products. A large quantity of the water used is for indirect cooling and only serves to lower the concentration of other pollutants. This includes water used in the primary coolers, wash oil coolers, and in the condensers of the benzol fractionation equipment. The most serious waste is that from the ammonia still. About eighteen to twenty-five gallons of ammonia liquor per ton of coal coked is produced and this is augmented by about 25 per cent in the ammonia stills by condensed steam. Although about 90 per cent of its phenol has been removed, it still contains some 300 ppm of phenol, about one per cent of calcium chloride, plus other organic and inorganic compounds that have high chemical and biochemical oxygen demands.

The saturators are a closed system and are not a source of pollution.

The water from the final cooler contains about 200 ppm phenol, about 100 ppm of emulsified naphthalene and various other inorganic compounds of the same nature as those found in the ammonia liquor. The water is collected in a sump and naphthalene scraped from the surface. The water, if sent to the sewer, would be a much larger source of phenolic waste than the ammonia still waste which has been dephenolized since there is about ten times as much final cooler water as there is ammonia still waste, which has only about twice the concentration of phenol. Since 1941 this water has been used for quenching coke which brings about a considerable reduction in phenol.

This practice while not too objectionable, does however cause some trouble. The water is both corrosive and, when recirculated, erosive since it picks up small abrasive particles of coke breeze. This combination is quite bad on pump impellers. We have found that nickel cast iron lasts quite well under such conditions.

The naphthalene, all of which does not settle out in the sump, plugs pipe lines and sprays. Thus we are turning to a recirculating cooling tower as will be noted later in the paper. The small quantity of overflow from this tower will not be too troublesome in the quenching system. The water from the quenching station would, however, be a source of suspended inert solids if not allowed to settle before disposal.

The remaining source of pollution is the light oil and benzol plant. Here the water separated in the light oil

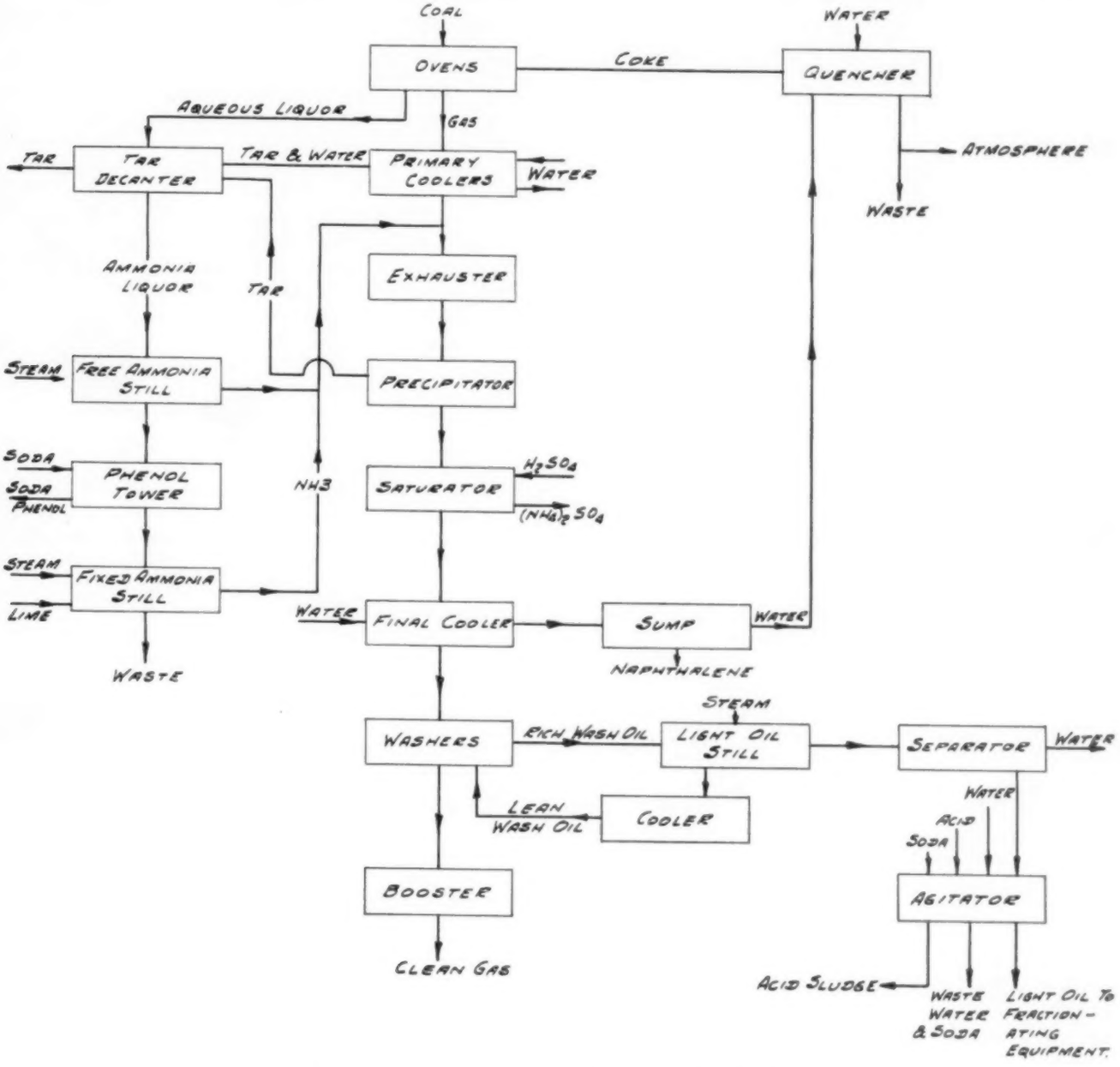


Figure 1 — Flow diagram of by-product coke plant.

condensation system, while free of solids, contains considerable dissolved organic materials, a source of B.O.D. The acid sludge, while not a direct stream pollutant, is a troublesome waste. We dispose of it by burning. The waste water and soda washes from the agitator go to the sewer. While small in volume, they are oxygen consumers because the spent soda contains a considerable quantity of sodium sulphite.

Now that we are familiar with the basic operations in the plant, let us consider how they have been altered in the past to reduce objectionable waste.

The history of pollution abatement at our Follansbee coke plant dates back to 1930 when one of the first vapor recirculation systems for the removal of phenol from ammonia liquor was installed. This one piece of equipment kept about 1200 pounds of phenol per day out of the river and had it not been for final cooler water, the phenol in our effluent would not have been of too much consequence. It was, however, one of several phenol contributors in the area, and a further reduction of all such contributions was desired.

A survey was made in 1941 and a material balance showed that 76½ per cent of the phenol entering the river came from the final cooler water, 18 per cent from the ammonia stills, and 5 per cent from the light oil condensers. Since final cooler water is not too objectionable for quenching coke, this was recommended and tried.

After two months of quenching with this water, another survey was made. The results showed that the final cooler water going to the quenching station had an average of 188 ppm phenol, while water from the quencher had 77 ppm. Considering that much of the water is lost at the quencher as steam and as moisture in the coke, this was a considerable reduction of phenol. Permanent arrangements were made for quenching with final cooler water and it has been done since that time.

During the war pollution abatement, while not forgotten, was pushed in the background by more important things. However, in 1946 we were requested by the West Virginia State Water Commission to make a complete analysis of our sewer effluent semi-annually. Fortunately we only have one outfall into the river, but it was still somewhat of an undertaking as we had never before attempted to measure flow at the sewer.

Even though the biggest part of our operation is continuous, we did not consider that grab samples would be representative and it was decided that 24-hour continuous samples would be taken for seven days. The first samples were taken by hand every 20 minutes. This required keeping a man at the sewer and it became desirable to devise an automatic sampling system. For this purpose we bought a 7 gallon per hour proportioning pump and collected 8 hour samples in a drum. The pump intake consisted of a pipe immersed vertically in a turbulent section of the stream and drilled with holes so that a cross sectional sample would be taken.

For flow measurement a rectangular weir was used. During the first sampling period the height of water above the notch was measured by a U-tube and a reading taken every five minutes. When the sampling pump was installed, a continuous water level recorder was devised by our instrument engineer.

A small laboratory size air pump was mounted on the water pump base and run from the same shaft. This was used to keep a small stream of air bubbling through a vertical section of pipe extending into the stream to the level of the weir notch. The pressure necessary to keep this pipe filled with air was recorded on a pressure recorder calibrated in inches of water.

The analytical methods used conformed, as much as possible, to American Public Health Association's "Standard Methods." There has been considerable criticism of the B.O.D. test for industrial wastes, but we have found that it gives fairly consistent results for coke plant wastes.

After the effluent had been measured and analyzed, we wished to put the information into a form that would give an over-all picture of pollution data to our management and to the State Water Board.

The form we used for presenting this data originated at the Yorkville, Ohio plant of the Wheeling Steel Corp. It not only records sewer flow and analysis but also the characteristics of the water supply and its distribution throughout the plant.

This diagram, Figure 2, shows, for the sage of brevity, only three days of sampling but is similar to those we send to the Water Commission after our semi-annual surveys. The flow figures listed are in gallons per day, the analytical results are in parts per million.

The first thing we wish to know is the nature of our water supply. Because a year round supply of low temperature cooling water is desired, wells are used rather than river water. The importance of analyzing the water supply is shown here. Note that two wells show a considerable oxygen demand. These wells were fcund to have been contaminated, a condition we had not previously suspected. The cause was determined and the condition is now being remedied.

Each well is equipped with a positive displacement meter so that we have very accurate measurements on the water to the plant. The water from the wells is pumped to a sump. The composite analysis listed is that for water going to this sump. The flow quantities listed are the sums of the individual meter readings. When the plant demands exceed the well production, some service water is pumped from our steel plant on the Ohio side of the river. This water is also metered and goes to the sump. The river pump is for emergency only.

The ammonia liquor produced may be determined by direct measurement. Moisture condensed from the gas at the final cooler may be calculated, knowing the temperature drop and assuming the gas to be saturated.

Water from the sump is distributed to the various pieces of equipment in the plant. It goes to the final cooler, wash oil coolers, primary coolers, to the ammonia still in the form of milk of lime, to the benzol plant as condenser water, to the air compressors for cooling, and to a group of company houses nearby for fire hydrants. Metered water is also furnished to the nearby sintering plant which has its own sewer outlet.

As mentioned before, final cooler water is used for quenching coke, part of it going from the quenching station to the sewer and part of it to the atmosphere as steam.

About one-third of the primary cooler water is used to flush out the ash pits below the boilers. This, incidentally, results in some inert suspended matter in the sewer.

Some condensed steam from heaters at the benzol plant is used for feedwater on locomotive cranes. This water eventually goes to the atmosphere.

Metered feedwater to the boiler house is supplied by the steel works across the river. Drinking water for the coke plant and the company houses is supplied by the city of Follansbee.

The effluents from all the equipment, as well as domestic waste from the plant and houses, are collected in one main sewer. The analysis for the sewer as well as measured flow at the weir is reported for each day during the test. Also recorded here is the sum of the metered inputs to the various parts of the plant. The difference represents losses to the atmosphere in the plant.

It is evident from a comparison of sewer and service water analysis that the impurities added to the water are materials causing B.O.D., chlorides, suspended and dissolved solids, ammonia, and phenol. Note that hardness is decreased somewhat.

The easiest and cheapest time to institute changes in operation and waste disposal is during an expansion or building program. We are now rebuilding and expanding our coke plant and are taking the opportunity to make all changes that will decrease pollution from the plant. The expansion program necessitated the installation of new by-product equipment of sufficient

capacity to handle by-products from both the old and new ovens.

The biggest improvement will be a recirculation system for the final cooler. A two-section tower will use mostly recirculated water for cooling the gas. Only a small amount of water from this cooler will be used for quenching and phenol from this equipment will be eliminated. Water from the light oil separators will be used for make-up water in the recirculation system. This is distilled water and will prevent dissolved solids build-up in the system. At the same time a troublesome waste will be eliminated from the sewer since this water contains phenol and other oils.

The only remaining source of phenol will then be the partially dephenolized ammonia still waste. The vapor recirculating phenol tower now in use is being studied with the view of increasing its efficiency. To reduce phenol in our effluent to the 135 lb per day limit proposed by the West Virginia State Water Board during the winter months will require at least a 95 per cent removal of phenol from the ammonia liquor in the phenol tower, and in the ammonia stills as opposed to our present 83 per cent removal.

This required removal will be difficult or perhaps impossible in this system. This means that other methods of disposal must be developed if we are to escape the abomination of quenching with still waste as many coke plants are now doing. Quenching with still waste is costly because of excessive equipment corrosion which is unfortunately hard to estimate and likely to be overlooked. Other processes for the removal of phenol which are being investigated are the bacterial decomposition in a trickling filter or domestic sewage plant.

During the early part of the construction period previously mentioned, the sewer system was changed so that domestic sewage could be segregated from industrial waste, if and when that becomes necessary.

The next step in the steel making process is the blast furnace. The major pollutant from this area is flue dust from the gas washers where large volumes of water are used. Some of this dust is of the size range of less than one micron so that simple sedimentation requires a long settling period, and consequently a larger settling basin than most plants would care to make room for. A more practical method would be to use a coagulant for clarification of this water. One water treatment company has recommended ferric sulphate as a coagulant, but ferrous sulphate could be substituted if proper pH control were maintained. This would permit use of neutralized pickle liquor as a coagulant. The free acid content of the waste liquor could be removed by treatment with scrap, and the pH of the neutralized liquor raised still further, if necessary, by the addition of waste alkalies from other parts of the plant. The use of pH control apparatus might be necessary for a process such as this because the pH of the river water will vary considerably from day to day. We have found that the pH of the gas washer water varies with that of the river so that fixed dosages of a neutralizing agent would not be satisfactory. Because pickle liquor is usually dumped intermittently it would be necessary to have a storage basin or tank so that a constant supply of uniform composition would be available for such a process.

The fact that gas washer water has, in itself, a certain amount of alkalinity both in solution and in very fine suspension is, we think, significant.

One sewer effluent at our plant, containing both blast furnace and pickler wastes did not exhibit any of the acid-iron characteristics that we had anticipated. A continuous sampling program for one week at this sewer showed that the effluent had a pH varying from 4.8 to 6.6, sulphate varying from 290 to 460 ppm, and soluble iron, less than one ppm. The increase in dissolved solids and sulphate ion over the amount found in the water supply does not account for nearly all the acid used by the picklers. Investigations on this effluent are not complete, but it is apparent that some neutralization and precipitation of iron hydroxide and calcium sulphate has taken place by the combination of these two wastes. If the suspended matter were removed from this effluent it would certainly not be objectionable.

We think that flue dust suspensions have definite possibilities as neutralizing agents. If the acid wastes are kept uniform by collection in a surge tank, and if the up-stream acid load is reduced so that the water supply maintains a more uniform pH, a neutralization and solids removal system might be erected without too much expense.

The reaction between the alkali-flue dust bearing washer water and the waste pickle liquor are no doubt similar to those occuring in the Lewis process for treating domestic sewage where alkali, electrically precipitated dust from cement plants, and ferrous sulphate are added after preliminary oxidation with ferric chloride. This neutralizes the effluent, removes suspended solids and absorbs about 70 per cent of the oxidizable domestic waste.

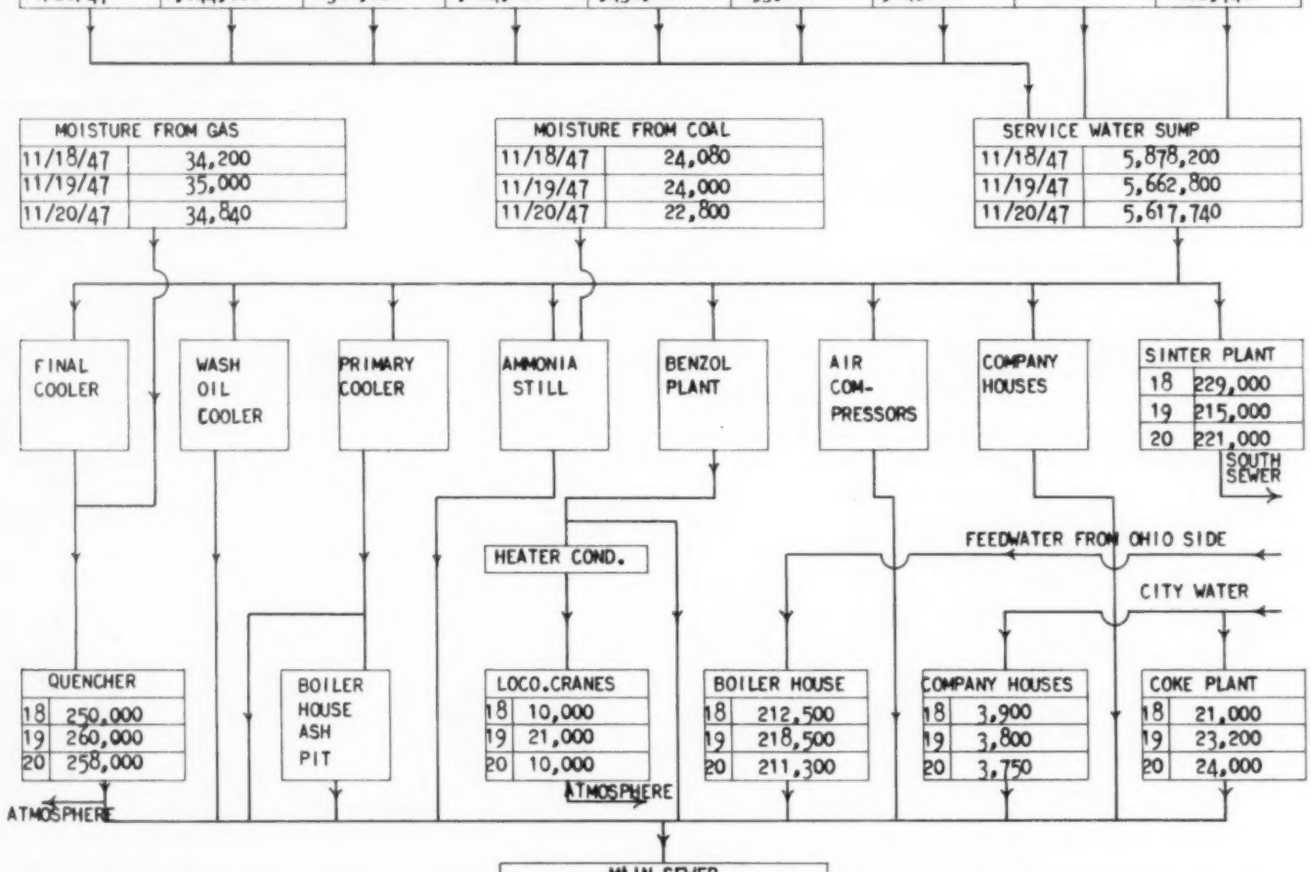
The next operation of the steel plant to be considered are the open hearths, soaking pits, and rolling mills. Although these operations constitute a major portion of the plant, they do not produce any objectionable aqueous wastes. Most of the water used is for cooling and most of the scale from the rolling operations settles out quickly and only a small settling basin is necessary to recover it. Palm oil, when it is not permanently emulsified, can be recovered profitably by the installation of a decantation sump. Other oils and grease losses to the river can, in most cases, be materially reduced by better housekeeping.

Waste pickle liquor, probably the most notorious of steel plant wastes, has been a subject of widespread discussion. The relative cheapness of sulphuric acid has not made it imperative that it be used too sparingly. If it had to be recovered or neutralized perhaps there would be less acid used. Improved design to prevent leakage and reduce drag-out will cut acid waste and a routine acid testing program will better regulate its use.

This is not a review of the literature, therefore we will not attempt to discuss all of the many processes that have been developed for neutralization and recovery of waste acids. The Iron and Steel Institute has maintained a fellowship at the Mellon Institute on waste pickle liquor since 1938. Doctors Hodge and Hoak of this fellowship have investigated the subject very thoroughly and have developed some processes that may prove attractive to the industry.

WELL WATER ANALYSIS							
	NO. 2 WELL	NO. 3 WELL	NO. 4 WELL	NO. 6 WELL	NO. 7 WELL	NO. 8 WELL	COMPOSITE
pH	6.7	6.7	6.4	7.7	7.6	7.4	6.5
B.O.D.	2	6	0	2	85	25	18
ALKALINITY	93	78	77	97	168	144	103
CHLORIDES	32	24	27	39	35	28	30
SULPHATES	298	270	270	298	185	185	256
HARDNESS	180	162	158	174	160	148	158
DISS.SOLIDS	440	390	410	410	380	340	390
AMMONIA	0.5	0.4	0.4	0.7	0.5	0.5	0.5

DATE	NO.2 WELL	NO.3 WELL	NO.4 WELL	NO.6 WELL	NO.7 WELL	NO.8 WELL	RIVER PUMP	OHIO SIDE
11/18/47	1,061,000	483,000	1,135,000	1,479,000	715,000	936,000	NOT OPERATING	69,200
11/19/47	1,005,000	566,000	1,072,000	1,393,000	656,000	883,000	"	87,800
11/20/47	1,044,000	368,000	1,104,000	1,432,000	653,000	914,000	"	102,740



DATE		11/18/47	11/19/47	11/20/47
METERED INPUT TO PLANT		5,684,880	5,471,300	5,425,430
OUTPUT WEIR MEASUREMENT		4,680,000	4,300,000	4,670,000
pH		8.1	7.2	7.3
5 DAY B.O.D.	P.P.M.	64	68	63
ALKALINITY	"	160	104	107
CHLORIDE	"	222	175	176
SULPHATE	"	256	298	284
HARDNESS	"	114	128	106
SUSPENDED SOLIDS	"	130	30	110
DISS. SOLIDS	"	680	720	700
TOTAL SOLIDS	"	810	750	810
SETT. SOLIDS	"	400	300	150
AMMONIA	"	1.5	3.0	4.0
PHENOL	"	11	13	16

Figure 2 — Regular surveys are made of water flows which include analyses of the water. Data for three days are given in this chart.

Many processes have been tried and they may be placed under the following classifications:

1. The production of copperas or some other hydrate of ferrous iron by various evaporation, crystallization, and filtering methods.
2. Oxidation processes producing ferric sulphate or ferric oxides.
3. Production of a lime and iron hydroxide known as "ferron."
4. Neutralization by coke oven ammonia and production of iron oxides and ammonium sulphate.
5. Neutralization by zinc oxides and production of zinc salts.

All of these methods have merit but no one of them could be adopted by the industry without flooding the market for the resulting by-product. It is possible, however, that the use of several of these processes by various members of the industry might reduce pollution considerably and still not saturate the market. The rouges, pigments, building materials, and flocculating agents that result from pickle liquor recovery could make these methods economically feasible if they are not produced in too great quantities. Coagulants such as ferrous and ferric sulphate will be needed in greater amounts for new sewage plants being built.

However, the greatest promise of reduction in pollution from the steel industry, we believe, will come from changes in processes rather than from treatment of wastes.

When reference was made earlier in the paper to the combined flue dust and waste pickle liquor effluents, mention was made of waste alkalies occuring in the steel plant. Sludge from a boiler water treating plant contains but little free lime but is an excellent source of finely divided calcium carbonate and could be used for partial neutralization. Many steel plants produce acetylene gas for burning and welding from calcium carbide. The sludge from such a plant is almost entirely finely divided calcium hydroxide and is, therefore, an excellent neutralizing agent. These with the alkaline water from the blast furnace gas washer should be used to neutralize and treat waste pickle liquor.

Companies engaged in galvanizing of steel have still another waste zinc dross that can be used to neutralize waste acid, and produce valuable chemicals. Such a process is now in operation at Wheatland, Pa. It is said to be especially interesting for pickle liquor containing both sulphuric and hydrochloric acid.

Large amounts of cooling water are used in the steel industry, especially in the blast furnace and open hearth. This water is returned to the river uncontaminated and may be a little lower in hardness than the original river water. If this water comes from wells it will dilute the plant's wastes thereby minimizing their harmful effect. If river water is used, however, there is no such dilution.

In most plants sewers were not planned. The sewer system just grew up with the rest of the plant and large quantities of relatively pure cooling water are mixed with smaller quantities of highly contaminated wastes which may someday have to be treated. A well planned sewer system would keep cooling water segregated from contaminated wastes until after they had been treated. Thus in new plants, sewers should be laid out with the pollution problems ever in mind, and in developing new processes thought should be given to the recovery of all wastes as by-products.

In this paper we have discussed briefly each contaminating effluent occurring in the manufacture of iron and steel. We have emphasized coke plant wastes both because our work on them has been more complete, and because we feel that they have not received as much consideration by the industry as has waste pickle liquor. We have tried to emphasize that the first phase of pollution abatement is a complete definition of the effluent which can only be accomplished by identifying and tracing each component to its source. Pollution abatement should, of course, start by carefully considering each operation and making all changes that will reduce waste and thus recover valuable material. This is simply efficient operation and good housekeeping. Most plants have already passed this stage and are now considering means of recovering dissolved and suspended materials that occur in such forms that recovery is not economical but is still necessary if we are to have clean streams.

In closing, we wish to emphasize that we of the steel industry as a whole have made a determined effort since 1930 to reduce our contribution to stream pollution.

DISCUSSION

PRESENTED BY

RICHARD D. HOAK, Senior Fellow, Mellon Institute, Pittsburgh, Pa.

C. VANCE THOMPSON, Chief Chemist, Coke Plant, Crucible Steel Co. of America, Midland Works, Midland, Pa.

P. E. JORDAN, Wheeling Steel Corp., Steubenville, Ohio

O. L. MAAG, Lubrication Engineer, Timken Roller Bearing Co., Canton, Ohio

L. A. KRAEMER, Superintendent, By-Product Coke Div., Pittsburgh Steel Co., Monessen, Pa.

K. N. BUNDY, Wheeling Steel Corp., Steubenville, Ohio

Richard D. Hoak: I think perhaps the most important point that was made in the paper was the fact that the place to prevent industrial waste pollution of streams is in the mill itself. All too frequently, the amount of waste that is produced by a given mill is greatly in excess of what it ought to be. We frequently run across instances in which mills have studied ways in which they can change their technique without adversely affecting the quality of the product, and by so doing reduce their contribution of waste materials to streams.

Of course, as many of you know, my principal interest is in the treatment and disposal of waste pickle

liquor, and I oftentimes think that the amount of acid and the excessive amounts of rinse water that are discharged could be reduced considerably. As a matter of fact, only recently I heard from the chief engineer of the Illinois Department of Health, telling me that two mills had made an amazing reduction in the concentration and volume of the waste water they were discharging from their pickling plant, simply by studying their operation carefully and changing their technique.

I wish that all of you who have to do with these operations would make a careful study of them to see wherein there are opportunities for reducing the concentration and volume of wastes. I am sure you will find a good many places where such things can be done.

Another point, which is complementary to the one that I just made, is the fact that in attempting to recover values from the majority of the steel mill wastes, we are dealing for the most part with relatively low-cost chemicals; that is especially true of waste pickle liquor. Mr. Bundy spoke several times about the opportunity of recovering valuable by-products. I would not want you to go away with the impression that there are a lot of valuable by-products than can be recovered by dealing properly with steel mill waste materials. I am afraid there are not many. If you can recover products that will cover a substantial part of the cost of treating wastes, to reduce the contribution of the industry to stream pollution, I believe that this is about the best that you can expect to do.

There are a few instances where values can be recovered. Mr. Bundy mentioned the treatment of waste pickle liquor with coke oven gas; if such an operation is carried out on a sufficiently large scale it can be operated at a profit, but it is the sort of process which can be utilized economically only by the very large producers of pickle liquor.

At Mellon Institute we have studied the treatment of pickle liquor with raw coke oven gas quite intensively, and we feel that we have overcome all of the technological problems that are involved, as far as we can carry them on a laboratory scale. The next step should be the installation of equipment on a sufficiently large scale for economic evaluation. We feel that it is a good process, and although we have developed a technique for treating pickle liquor with pure ammonia, that would not be nearly as attractive to the industry as a whole as would be the treatment of pickle liquor with raw coke oven gas. We have been able in the laboratory, using an impure ammonia liquor, to produce an ammonium sulphate which is probably of higher grade than that which is now being produced in many saturators with raw coke oven ammonia. Obviously we cannot study this development at the Institute with coke oven gas; pilot plant work can be done only in a steel mill.

We have been hopeful that someone in the industry will provide us with pilot plant equipment for the evaluation of our method of treating coke oven gas with waste pickle liquor, and if anyone is successful in selling their management on the idea of providing the equipment, we will be only too happy to cooperate in operating it.

C. Vance Thompson: I have spent some time trying to determine phenol, and the only question I would like to ask, has anybody been able to find a cheap way of getting rid of the residual, five to ten per cent, or 17 per cent I believe it is in the case of Mr. Jordan's plant? I have tried various solvents and various processes in getting rid of phenol in ammonia liquor and ammonia still waste and found that tri-cresyl phosphate was the best solvent for phenol removal, but it is 37 cents a pound, and maybe somebody else has a better solution on a 90 to 95 per cent phenol removal.

P. E. Jordan: I do not believe we have found a cheap method yet. Over at Philadelphia, some operators claim that they are reducing it to about 50 ppm by the vapor recirculation process. We hope our recirculation tower can be improved sufficiently to reproduce these results. If so, we are in good position; if not, we still have the problem.

C. Vance Thompson: I believe West Virginia does not require the complete removal, where in Pennsylvania we have to obtain complete removal, and that offers a different situation. Do you have any comment on that?

P. E. Jordan: We are allowed 135 lb per day during the winter, and 500 lb during the summer. West Virginia believes this will bring the river down to a point where there will be no objection to phenol in the city water plants.

O. Maag: Are there any efficient methods for removing traces of oil that get in from the greases and oils used on the mill bearings, methods more efficient than the weirs that are usually used?

P. E. Jordan: The removal of small traces of oil is complicated by the large volumes. If the sewers are laid out properly, probably it could be done fairly cheaply with filter beds or settling tanks or something like that processing only the contaminated water. This is one point where the steel industry should concentrate on getting their contaminated effluents down to as small a volume as possible, large volumes make treatment very expensive.

L. A. Kraemer: I might add a comment on that. I was at a meeting in New York, and one of the oil companies has a filter which they claim will remove all oil.

WANTED!

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A Decade of Expansion

AT BETHLEHEM'S SPARROWS POINT PLANT

A Decade of Expansion

. . . AT BETHLEHEM'S SPARROWS POINT PLANT

By T. J. Ess

▲ WHEN the late Charles M. Schwab said, some 23 years ago: "My hope is that eventually we shall have at Sparrows Point the greatest steel plant in the world," there were no doubt many who held the statement to be more or less wishful thinking. Subsequent developments, however, have brought Mr. Schwab's hope close to realization. The Sparrows Point plant of Bethlehem Steel Company is today the second largest in the world, and its operating records compare favorably with any other plant.

Favored by its tide-water location and its proximity to centers of steel consumption, the Sparrows Point plant presents a saga of constant expansion, and a tangible refutation of the "anti-expansion" criticism that is at present leveled against the steel industry. Just eleven years ago, the Iron and Steel Engineer had the privilege of publishing a complete description (AISE Proceedings, 1938) of this plant, which then had annual capacities of 1,775,000 net tons of coke, 2,105,000 net tons of pig iron, and 3,320,000 net tons of steel ingots.

As it now stands, Sparrows Point has annual capacities of 2,520,000 net tons of coke, 3,252,000 net tons of pig iron, and 4,666,000 net tons of ingots, all considerably higher than the figures of eleven years ago. Its list of products is widely diversified, and includes by-product coke, coke oven gas, tar, ammonium sulphate, benzol, toluol, xylol, crude solvent naphtha and crude pyridine oil; basic and bessemer iron; basic open hearth and bessemer ingots; sheared and universal plate; flanged plate products; rails; concrete reinforcing bar; skelp; butt and lap welded pipe; galvanized pipe; wire rod; wire (bright, bethanized and galvanized); wire strand; nails, staples, barbed wire, bale ties, etc.; black plate; tin plate (hot dipped) and electrolytic; terne plate; and hot rolled, cold rolled, and galvanized sheets.

The location on tidewater enables the Sparrows Point plant to receive much of its raw materials (as well as to ship some of its products) in ocean-going vessels. Iron ore is received from South America, Africa, Sweden and the lake region. The bulk of it is received via water in large ocean-going ore carriers, from which ore is removed by bridge unloaders and piled in the storage yard immediately adjacent to the river dock. From the yard, ore is moved to the stock-bins of the various furnaces in electrically driven dump cars.

Domestic ores arrive in railroad cars which are unloaded by a car dumper.

Ore storage, which has been expanded to a length of 2500 ft, will accommodate approximately 1,000,000 tons. Ore handling facilities have been expanded by the addition of a new unloader bridge crane. Of 366 ft span, the bridge has a travel speed of 80-100 fpm, depending upon wind velocity. The trolley travels at speeds up to 1000 fpm, and the hoist has a speed of 225 fpm. The bucket is of the two-rope grab type, with a capacity of 240 cu ft.

The bucket empties the ore into a 60-ton storage bin, which in turn feeds into a 50-ton weighing hopper that is movable so it may dump into railroad cars on any one of three tracks spanned by the portal pier of the bridge.

All electric motors on the bridge operate under 230 volt d-c current with magnetic control.

Coal, shipped from mines in Pennsylvania and West Virginia by rail, is received at coal piers where it is unloaded by car dumper on to scows which are towed by tugboat to the plant at Sparrows Point. The coal is unloaded from the scows and stocked by two 361 ft span

traveling bridge cranes which also reclaim coal from storage for the coke ovens. Coal storage averages about 300,000 gross tons. Normal plant operation requires about 3,250,000 tons of coking coal per year to supply the 483 ovens now operating.

Limestone is received by rail, principally from Pennsylvania, and is unloaded by car dumper.

COKE OVENS

Coking facilities have been expanded through the addition of two new batteries totaling 122 low differential, underjet ovens. These batteries are located end to end in a line paralleling the line formed by the six older batteries. The new ovens are 40 ft 5½ in. long between door linings, and 12 ft high, floor to roof. Oven width is 17¾ and 21¾ in. in one battery, and 18¼ and 21¼ in. in the other. Each oven takes a coal charge of 19.1 net tons, which is approximately two-thirds high volatile coal and one-third low volatile. The coal is pulverized so that 80 per cent will pass through ⅛ in. mesh screen, and bulk density is controlled by regulating the moisture content of the coal and by spraying it with oil.

The ovens are regenerative, and are heated with blast furnace gas, with coke oven gas available as a stand-by. Thus all coke oven gas averaging 10,500 cu ft per net ton of coal coked is normally available for other uses, including heating furnaces, soaking pits, open hearths, heat treating furnaces and boilers, and for sale to the city of Baltimore.

Each battery is equipped with one pusher machine, one coke-side door machine, one gantry type charging larry, and one coke quenching car. A single 3000-ton overhead coal bin serves both batteries, as does a single quenching tower.

The new batteries are served by the previously existing coal handling equipment, with an extension to the conveyor system to reach the new storage bin. The four existing pulverizers have a central feed, reversible design, and are equipped with vibrating screens.

Coke from the new ovens is also handled by the previously existing system, with the addition of a new coke wharf, a ½ in. stationary grizzly screen and three new conveyor galleries connecting the wharf to a receiver located over the blast furnace trestle.

Under normal operation, 162 ovens are pushed from the new batteries in 24 hr, coking 3094 tons of coal per day. Furnace coke yield averages about 71.5 per cent, with approximately 2.5 per cent breeze.

The addition of the two new oven batteries necessitated partial replacement and relocation of coal chemical recovery equipment. By-product equipment installed includes four primary coolers, four turbo-exhausters, five electric precipitators, five reheaters, four saturators, four acid separators, two flushing liquor decanter tanks, two tar and ammonia collecting tanks, two gas compressors, twelve banks of shell and tube ammonia liquor circulating coolers, one 7-ft ammonia still, one sulphate dryer and one pyridine plant.

◄ **E. G. GRACE, Chairman**

ARTHUR B. HOMER
PRESIDENT

S. J. CORT
VICE PRESIDENT

C. E. CLARKE
GENERAL MANAGER

Gas leaving the tar precipitators and gas reheaters contains approximately 80 per cent of the ammonia originally contained, the remainder having been washed out by the condensate formed in cooling to 38 C in the primary coolers. This condensate (or ammonia liquor) is charged continuously to an ammonia still, where steam and milk of lime act to remove the ammonia, hydrogen sulphide, etc. The greater portion of the ammonia from the still is then reintroduced into the gas stream as it leaves the reheaters. At this point, therefore, the gas contains practically all of its original ammonia, and its temperature has been raised to 65 C in the reheaters.

The gas then enters the saturators, where it bubbles through a dilute solution (normally 5.5 per cent) of sulphuric acid. As ammonium sulphate forms, the solution becomes saturated, and sulphate crystals form and settle to the conical bottoms of the saturator. These crystals, together with some of the solution, are pumped as a slurry to settling tanks at the sulphate dryer. The clear liquor from the top of the tanks, along with makeup 66 degree Baumé sulphuric acid, is returned to the saturators, while the thickened sludge from the bottom of the tanks is fed to the sulphate dryers. One large drum filter dryer, put into operation recently, handles the entire production. Four previously existing centrifugal dehydrators provide standby protection. It is also planned to install two new centrifugal units. In the dryer, the sulphate crystals are deliquored, rinsed with dilute ammonia liquor, dried, and then discharged onto a conveyor belt which carries the product to storage.

Sulphate production normally runs 20-21 lb per ton of dry coal, and approximately 7.5 gal of tar is recovered per ton of dry coal.

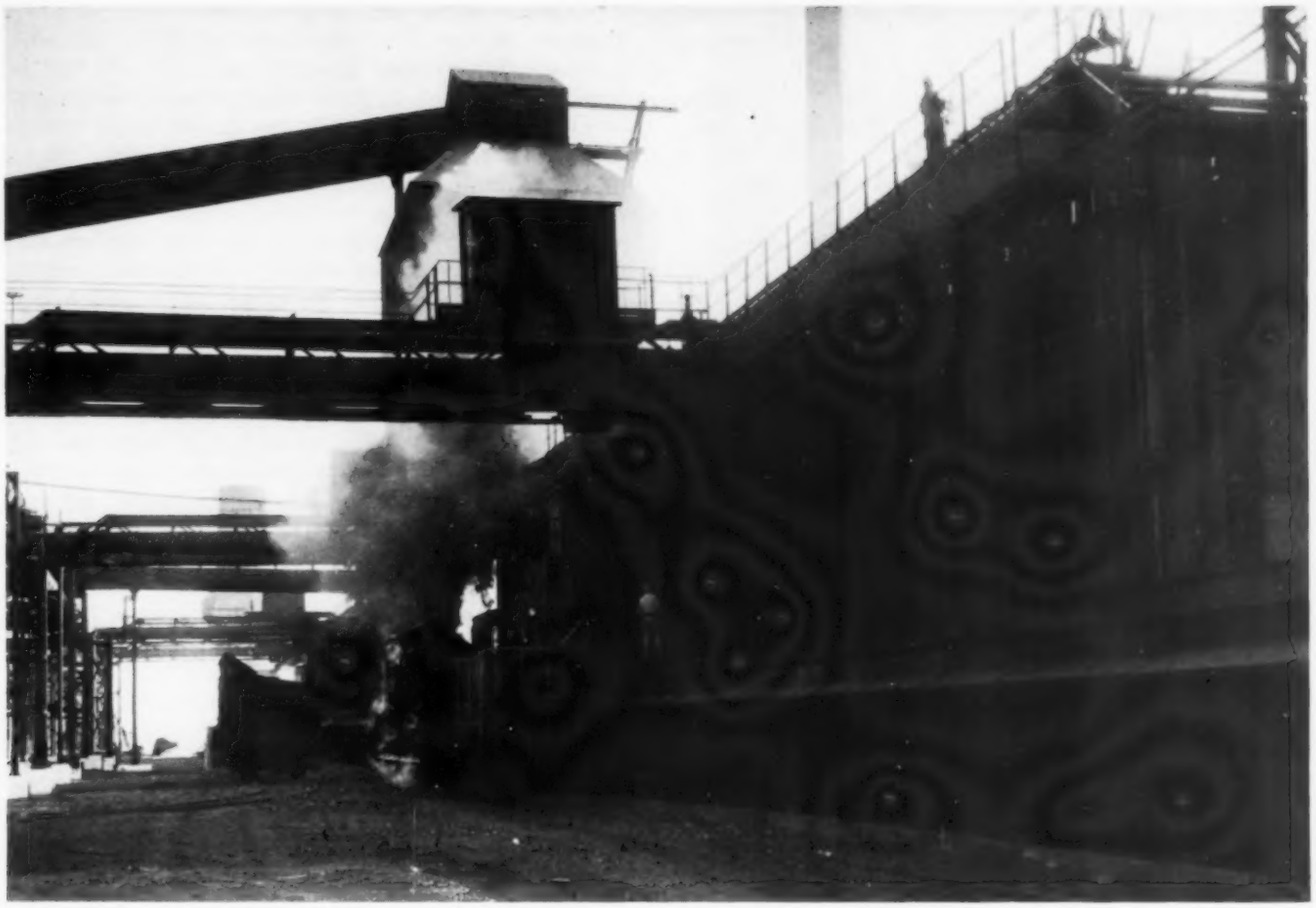
Approximately 5 gpm of the clear mother liquor leaving the settling tanks is charged into the pyridine still. A side stream of relatively pure ammonia vapor plus steam is taken from the ammonia still, cooled to 95 C, and introduced into the still to neutralize the acid mother liquor. Upon neutralization, the pyridine homologues are sprung from their chemical combination with sulphuric acid. The reaction of ammonia with acid is accompanied by the formation of considerable heat, which causes the pyridines, along with some water, to pass off as a vapor at about 103 C.

This vapor passes through a partial condenser which removes part of the water. The vapor, at 93-98 C, then passes to a condenser. From here, the condensate flows by gravity to a separator, while the uncondensable vapor is vented off. The specific gravity of the water layer in the separator is adjusted to approximately 1.1 by adding mother liquor, and the liquor, together with that from the partial condenser returns to the pyridine still by gravity. Crude pyridine, with a specific gravity of 1.00, is withdrawn from the separator to the collector. From the collector it drains to the storage tank. The neutralized mother liquor overflow from the still is returned to the saturators. The crude pyridine recovered ranges 0.02-0.025 gal per ton of dry coal.

The light oil process has been completely replaced and the process modified to a modern semi-continuous refining operation. The equipment for light oil recovery includes three bubble cap column stripping stills, three vapor-to-oil heat exchangers, four final benzolized oil heaters, three light oil rectifiers, three light oil condensers, six light oil separators, eight shell and tube debenzolized oil coolers, two wash oil purifiers, and miscellaneous circulating, surge and decanter tanks.

Light oil refining is effected in the following new equipment: One carbon disulphide rectifying column and condenser, two nitration benzol rectifying columns and condensers, one pure toluol and xylol column, one 30,000 gal pure toluol and xylol still kettle, two vapor neutralizers, one toluol and xylol condenser, one crude products rectifying column, one 10,000 gal crude products still kettle, two 10,000 gal agitators, two 500,000 gal benzol storage tanks, one 150,000 gal benzol storage tank, one 100,000 gal benzol storage tank, one 350,000 gal toluol storage tank, one 100,000 gal xylol stor-

The ore storage yard, accommodating approximately 1,000,000 tons of ore, is 2500 ft long, and lies adjacent to the river dock.



Two new batteries of coke ovens have brought the plant's capacity up to 2,520,000 net tons of coke per year.

age tank, and miscellaneous tanks for crude and intermediate products, acid and caustic soda.

As previously stated, the light oil recovery and refining operations are continuous except for the refining of toluol and xylol. Benzolized oil from the light oil absorbers enters a surge tank from where it is pumped through the vapor-to-oil heat exchangers, the final heaters and the stripping stills. Direct steam in the stripping stills distills the light oil from the circulated absorbing oil, which is then returned to the light oil absorbers in the gas system after being cooled in the shell-and-tube coolers.

The stripped light oil is rectified into two fractions, the lighter of which, containing forerunnings, benzol, toluol and xylol, is condensed and passes through a separator for water removal, and on to storage. The heavier fraction solvent naphtha, passes through a separator and on to storage; it consists of about 13 per cent of the total light oil.

The lighter fraction is subsequently passed through the carbon disulphide rectifying column to remove forerunnings, and then, in batches of 10,000 gal, is given an acid and soda treatment for removal of foreign hydrocarbons and for neutralization. The treated oil is then pumped continuously into the nitration benzol fractionating columns, where the benzol fraction is distilled off as commercial refined benzol. The residue from this operation is accumulated for batch charging into the toluol and xylol still kettle, which volatilizes the charge for the pure products refining column.

The wash oil purifier is used to prevent the formation of sludge and deposits in the absorbing oil system. About one per cent of the debenzolized wash oil is continuously bled from the system into the purifier, where it is steam distilled, leaving all residue in the purifier for disposal. Total light oil recovery averages 3.2 gal per ton of coal carbonized.

Construction has already begun on still another battery of 65 underjet coke ovens, 16¼ in. and 19¾ in. wide, with double collecting mains and equipped for raw gas recirculation. This job will also entail extensive changes to coal handling equipment, and some additions to coke handling and by-product equipment.

BLAST FURNACES

During the past decade, two blast furnaces have been added to the six previously existing. In 1941, "G" furnace was built, with a hearth diameter of 25 ft 9 in., a bosh diameter of 29 ft 6 in., and a stockline diameter of 20 ft. The height of the furnace is 102 ft from iron notch to top ring. The iron notch is placed 18 in. above the bottom and the cinder notch is 4 ft 2 in. above the iron notch. Sixteen tuyeres are spaced around the furnace 3 ft above the cinder notch. The total height of the crucible section is 10 ft 5 in.

The bosh angle is 81 degrees 38 minutes, the sloping section being 12 ft 9 in. high and topped by a straight section 10 ft 4 in. high. The inwall section has a slope of

1.0426 in. in 12 in. and is 54 ft 8 in. high. The stockline section is 4 ft 4 in. high.

This furnace is served by four stoves 22 ft in diameter x 125 ft high, each containing 133,000 sq ft of heating surface. Blast temperature is automatically controlled.

An inclined skip with drop-bottom bucket is used to charge this furnace.

In 1948, "H" furnace was put into blast and in December this furnace established a world record with a production of 54,336 net tons of pig iron, an average of almost 1753 tons per day.

This furnace has a hearth of 28 ft diameter, a bosh of 31 ft 7½ in. diameter, and a stock line 21 ft 6 in. in diameter. From iron notch to top ring, it is 105 ft high. The hearth section totals 10 ft 5 in. in height, with the iron notch 18 in. above the bottom, the cinder notch 4 ft 2 in. above the iron notch, and the tuyeres of which there are 20, 3 ft above the cinder notch.

Above the crucible, the sloping section 12 ft 9 in. high, forms a bosh angle of 81 degrees, 54 minutes, 33 seconds, and is topped by a straight section 6 ft high. The inwall section, with a slope of 1.04 in. in 12 in., is 58 ft 5 in. high, and is topped by a stockline section 5 ft 4½ in. high.

The big bell, which has an angle of 50 degrees, is 16 ft 6 in. in diameter, leaving a 2 ft 6 in. annular space between the bell and the stockline lining.

Refractory lining is 48 in. thick in the crucible, 27 in. thick in the bosh, and 49½ in. thick in the stack and stockline section. The hearth jacket is made up of water-cooled staves, and copper cooling plates are provided in the lining above the cinder notch, up through the bosh and in almost the entire inwall section. There are three rows of cooling plates in the hearth, seven in the bosh section, and 15 in the straight and inwall sections. Cast steel wearing plates embedded in the lining protect the stockline section.

The stack provides working volumes of 38,204 cu ft in the inwall section, 8911 cu ft in the bosh, and 6318 cu ft in the crucible.

"H" furnace is charged by a conventional double skip, with cars of 300 cu ft capacity dumping into a rotating distributor top. Both bells are operated pneumatically, and a preset automatic charging control is provided. A charging sequence of ore, ore, stone, coke, coke, coke is normally used for straight filling. A 40-ton scale car operates beneath the high-line bins. Coke from the stock bin is screened before passing into a 300 cu ft weighing hopper and on into the skip car.

Blast volume averages about 91,000 cfm, and is preheated to about 1450 F in three stoves 28 ft in diameter x 133 ft 6 in. high, each containing 290,295 sq ft of heating surface. The stove cycle is normally 3¼ hr on gas and 2 hr on blast, and the blast temperature is maintained constant by automatic mixer valve control.

Gas leaves the furnace through four offtakes which merge into two risers and finally into a single downcomer. At the top, the gas usually averages about 350 F in temperature and 40 in. water column pressure. From the down-comer, the gas passes through a dust-catcher 41 ft 6 in. in diameter, and a gas washer 20 ft in diameter. Approximately 20 per cent of the gas then goes through a disintegrator for further cleaning before it is used in the hot blast stoves. The remaining 80 per cent goes direct from the tower washer to its points of consumption at soaking pits, boilers, etc.

During 1948 two thickeners were installed, each consisting of a single settling compartment 130 ft in diameter and 15 ft deep at the center. Water from the primary gas washers of E, F, G and H furnaces, a total of 11,000 gpm containing not more than 163 grains of dust per gal flows to these thickeners, and the sludge dust settles to the bottom of the compartment where a slowly revolving rake moves it down the sloping bottom toward the center of the thickener. Some 97 per cent of the water entering the thickener is decanted over the top edge of the compartment into a trough surrounding the tank and then passes to the sewer. This overflow usually contains less than 4 grains of dust per gal. The slurry formed in the thickener, containing about 2½ per cent of the water entering the tank, is

This blast furnace, the newest at Sparrows Point, established a world record with 54,336 net tons of iron for the month of December, 1948. It has a 28 ft hearth diameter.

pumped out of the bottom to a pond some 5000 ft distant for draining and storage.

In 1948, blowing facilities, which had included 14 gas-driven blowing engines, three steam-driven turbo-blowers and four vertical steam-driven blowing engines, were also expanded by the addition of two condensing turbo-blowers, each rated at 100,000 cfm at 30 psi, and operating on steam at 250 psi, 650 F. The blowers are not cooled, and their blast may reach temperatures as high as 300 F. These new blowers serve furnaces G and H, with a tie-line to the older units as stand-by.

Dry blast equipment was installed in 1942 to serve four of the furnaces then in operation. This consists of four units, totaling 950 tons capacity, using low pressure refrigerant, and capable of cooling the air to 41 F, giving a moisture content of 3 grains per cu ft.

Two new turbo-blowers, each rated at 100,000 cfm at 30 psi, serve G and H blast furnaces.

OPEN HEARTH

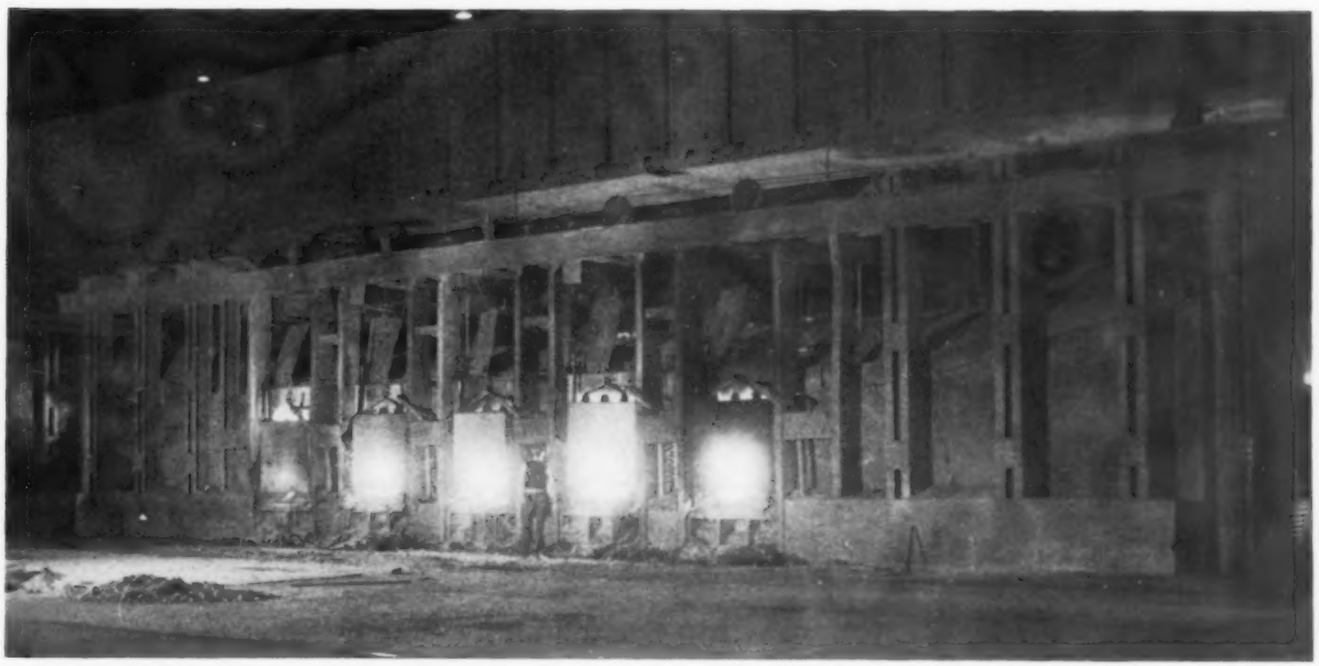
A major expansion of productive capacity consists of five open hearth furnaces that have been added to the No. 3 shop that formerly consisted of only six furnaces. These furnaces, 82 ft 7 in. long and 22 ft 3½ in. wide overall, have hearth dimensions at the foreplate line of 47 ft x 15 ft 9 in. giving a bath area of 742 sq ft. The hearth is built up with one inch of loam, 4½ in. of fireclay brick, 13½ in. of chrome brick, and 18 in. of a burnt-in mixture of 80 per cent ground magnesite and 20 per cent fine open hearth slag. The bath depth at the tap hole is approximately 27 in.

The furnace roof, 13½ in. thick, has a span of 19 ft 11 in. The roof profile is somewhat unusual in that it is essentially straight with the exception of a section 14½ ft long over each end of the furnace, where a constant slope of 3 in. per ft prevails all the way to the end walls.

Furnace proportions are such as to give a free, open flow of gases. The front wall is 5 ft 9½ in. high from foreplate to the bottom of the skewback channel, while the back wall is 4 ft 6½ in. Heights from the foreplate to the roof crown are 8 ft 2 in. at the center of the furnace, 8 ft 6 in. at the knuckle and 11 ft 6 in. at the ends of the furnace. No restriction, either horizontal or vertical, is inserted at the knuckles. The minimum cross-sectional area in the ends of the furnace is 50.5 sq ft. Uptakes are liberal, with a cross-sectional area of 82.9 sq ft at each end of the furnace.

The single slag pocket is 20 ft long, 15 ft 10½ in. wide, and, from floor to the crown of the arch, 13 ft 10 in. high, and is connected to the regenerators by fan-tails with a bridgewall area of 52 sq. ft.

Open hearth furnaces at Sparrows Point, equipped with two-pass checkers and burning fuel oil alone, have established some enviable records in production and economy.



Regenerators, completely insulated and steel encased, house two-pass checkers, with the two vertical down-flow passes connected by an idle vertical pass. Both regenerators are 25 ft 2 in. high, while the checkerwork therein is 13 ft 10½ in. high in the first pass and 14 ft 4 in. high in the second pass. The large chamber is 14 ft 1 in. wide, the small one 9 ft 1 in. wide. In each chamber, the first pass is 12 ft 10 in. long and the second pass 10 ft 6 in. long. The volume of checkerwork in the large regenerator is 4625 cu ft, with 2506 cu ft in the first pass and 2119 cu ft in the second pass. In the small regenerator, checkerwork consists of 1686 cu ft in the first pass and 1367 cu ft in the second pass, for a total of 3053 cu ft. The checkerwork is designed with vertical flues 7½ in. x 7½ in. in the first passes and 5½ in. x 5½ in. in the second passes.

Flues leaving the regenerators are 27.5 sq ft and 22.5 sq ft on each end of the furnace. Water-cooled slide damper valves are used. Furnace stacks are 225 ft high x 7 ft 6 in. inside diameter.

The furnaces are fired with bunker C fuel oil through multi-jet steam atomizing burners. Oil from the central plant storage flows to individual heaters at each furnace where its temperature is automatically brought to 200 F.

Both forced and induced draft is provided, with a fan rated at 14,000 cfm, 3 in. water column for the former and one rated either at 145,000 or 160,000 lb per hr, 10 in. water column for the latter.

Instruments and controls on each furnace include the following: Furnace pressure recorder, steam pressure recorder, oil flow meter, air flow indicator, temperature recorders for the first pass of the checkers and for flue gas temperature, automatic time reversal equipment, oil flow controller, combustion air flow controller, furnace pressure controller.

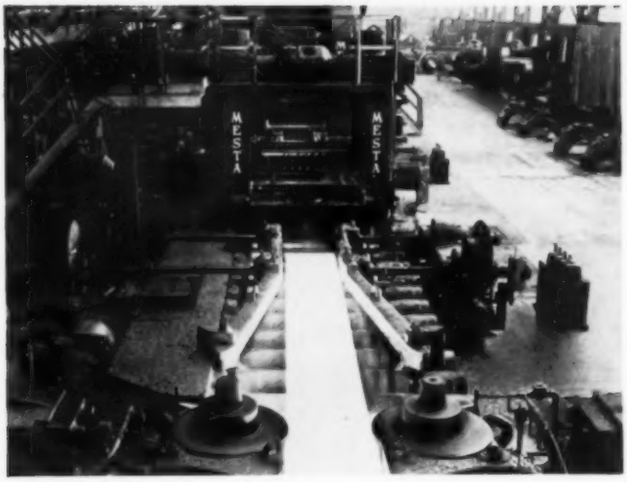
From a magazine elevator feeder, slabs are carried over a charging table and pushed into the heating furnaces preparatory to rolling on the 68 in. hot strip mill.

The furnaces operate on a hot metal charge of 50-60 per cent, turning out heats of 165-212 tons in less than 10 hours, tap to tap. Fuel consumption averages 3,248,000 Btu per net ton of ingots.

Steel is poured into a variety of molds of open top, capped and hot-topped types. Sizes range from 25 x 28 in. and 22 x 34 in. up to 31 x 51 in. and 26 x 66 in. Molds are dipped in tar before being filled.

Over the past decade, 20 waste heat boilers have been installed on the open hearth furnaces in No. 1, 2 and 3 shops, thus equipping all 28 furnaces. All of these are horizontal fire-tube units, 9 ft 6 in. in diameter x 21 ft 11 in. long and containing 470-2½ in. tubes, affording 6105 sq ft of heating surface. Approximately 103,000 lb of waste gases flow through each boiler each

The three furnaces on the 68 in. mill provide a total heating capacity for 330 net tons of slabs per hour.



Leaving the furnaces, the slabs first pass through the vertical edger shown in the foreground and then to a 2-high stand.

hour. Gas temperature drops from 1150 F to 530 F through the boiler. Steam, at 270 psi and 675 F, and 150 psi and 450 F, is generated at an average rate of 13,000 lb per boiler-hour.

The three 20-ton bessemer converters previously existing are still used, and provide an ingot-making capacity of 312,000 net tons per year.

68-IN. HOT STRIP MILL

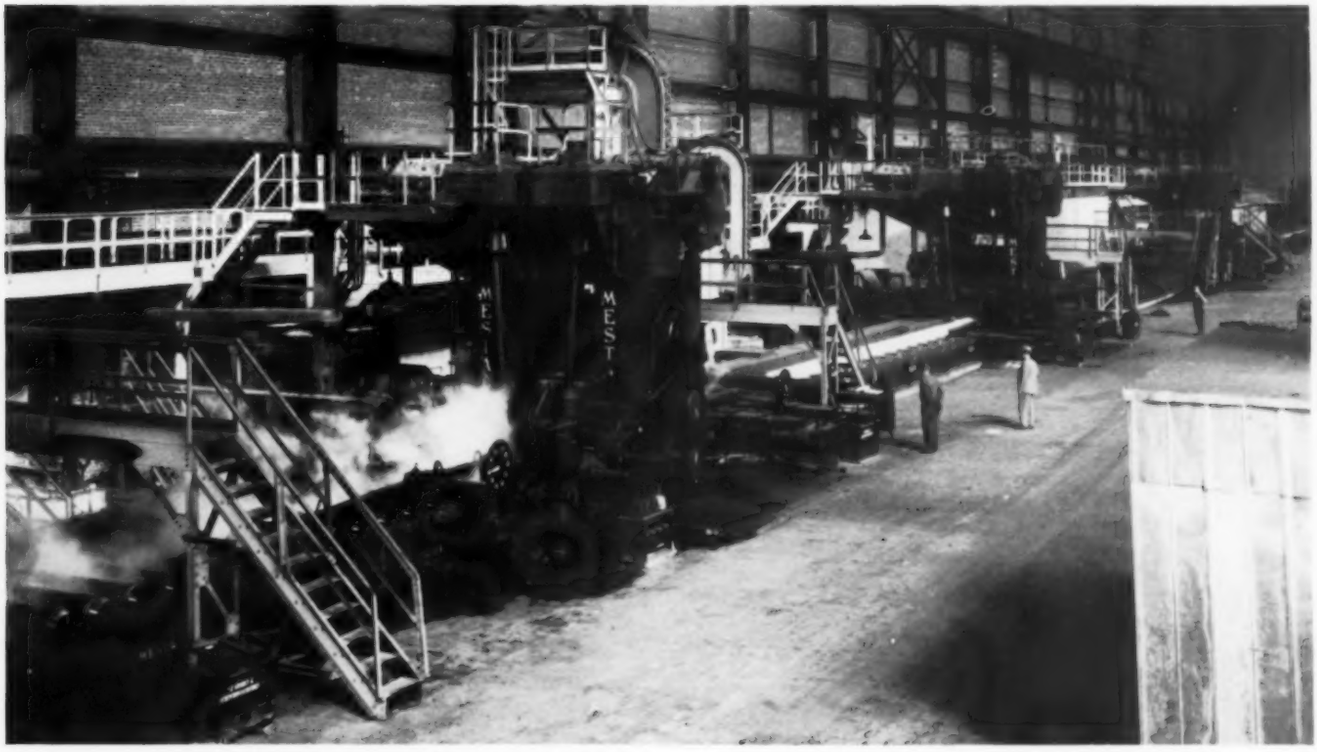
Rolling facilities of the plant were enlarged materially by the installation of a 68 in. hot strip mill which went into operation late in 1947. It is designed for a capacity of 140,000 tons per month, and rolls slabs 20-61 in. in width, 4½-6½ in. thick and 7-22 ft long, weighing up to 27,600 lb. The slabs, averaging 14,000 lb in weight come from previously existing primary mills, which include a 40 in. reversing universal slabber, a 46 in. reversing bloomer and a 40 in. reversing bloomer. The strip mill will produce 18 gage in widths up to 42 in., 16 gage up to 48 in. wide, 14 gage up to 54 in. wide, and 12 gage and heavier up to 60 in. wide. Thus, the 68 in. mill has increased the range of flat rolled products over that formerly available from the existing 56 in. hot strip mill.

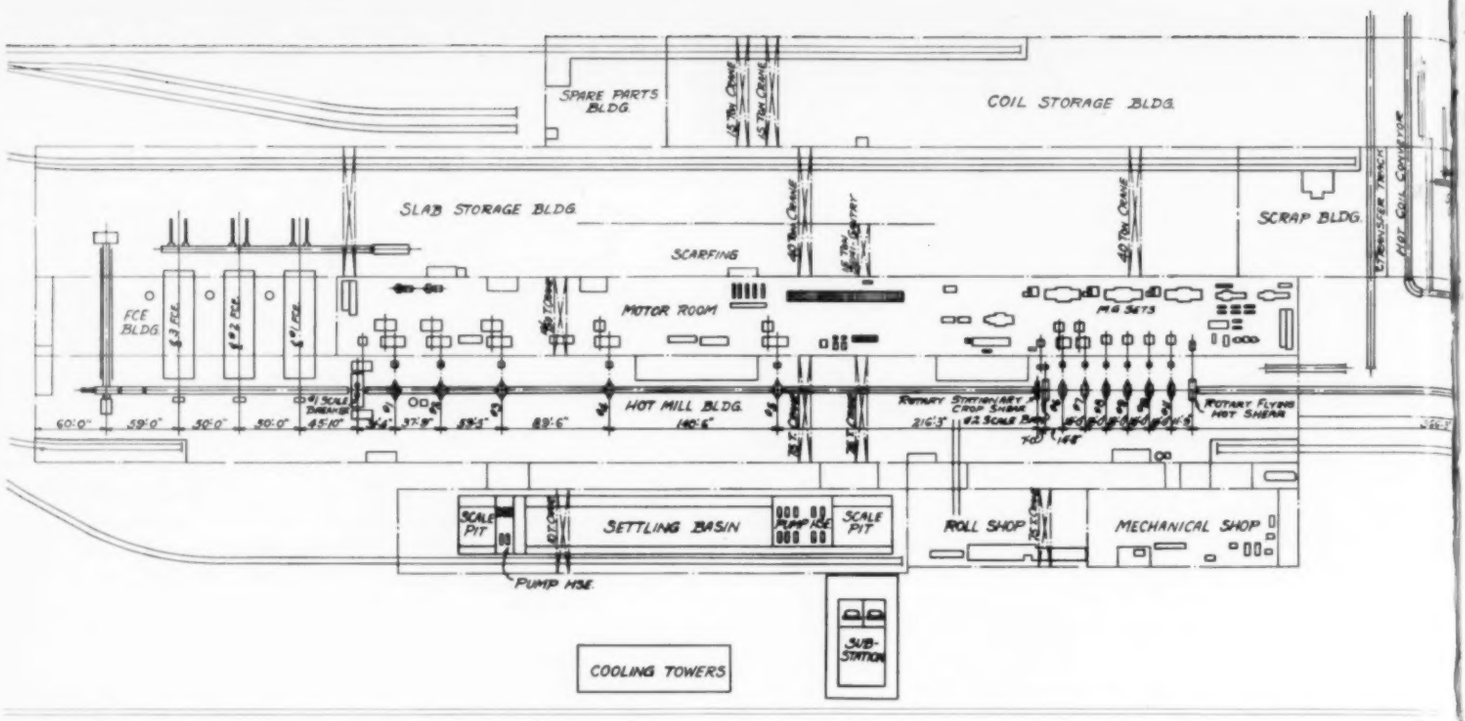
From the slab storage provided by a building 1000 ft long x 106 ft 5 in. wide, served by three 40-ton cranes, slabs are moved by crane on to a magazine elevator feeder, which in turn moves the slabs on to a 235 ft charging table running across the back ends of the slab furnaces. Double pushers, with air-operated clutches, serve to move the slabs from the charging table into and through the furnaces.

Heating facilities for the strip mill consist of three continuous, triple-fired furnaces, each with a rated capacity of 110 tons of steel per hour. These furnaces are 96 ft 9¾ in. long x 24 ft 6 in. wide, and are fired with fuel oil through steam-atomizing burners. Ten burners are used in the top of the main heating zone, and eight in the bottom, while eight more are placed in the soaking zone, which has a hearth length of 17 ft 3¾ in. Total maximum burner capacity is 1150 gallons of oil per hour per furnace. Each of the three sets of burners has its individual fuel input and fuel-air ratio controls, while automatic temperature control is provided for the main heating zone and for the soaking zone. Furnace pressure is also automatically controlled.

The furnaces are completely insulated and steel encased. Roofs are of flat, suspended arch construction. Located beneath each furnace are two double-pass sili-

The last three roughing stands, each driven by a 4500 hp motor, are equipped with integral vertical edging rolls.





con carbide tubular recuperators, which provide 4320 sq ft of heating surface for each furnace. Air for combustion is preheated to 450-500 F in the recuperator while flue gas temperature is reduced from approximately 1400 F to 850 F. A motor-driven fan rated at 75,000 cfm at 900 F and 3.8 in. water column furnishes the air to each furnace.

Slabs, at rolling temperatures averaging about 2250 F, are propelled from the furnace by the action of the pushers previously mentioned. Spring bumpers absorb the impact of the hot slabs as they slide down onto the mill approach table, which is 189 ft long.

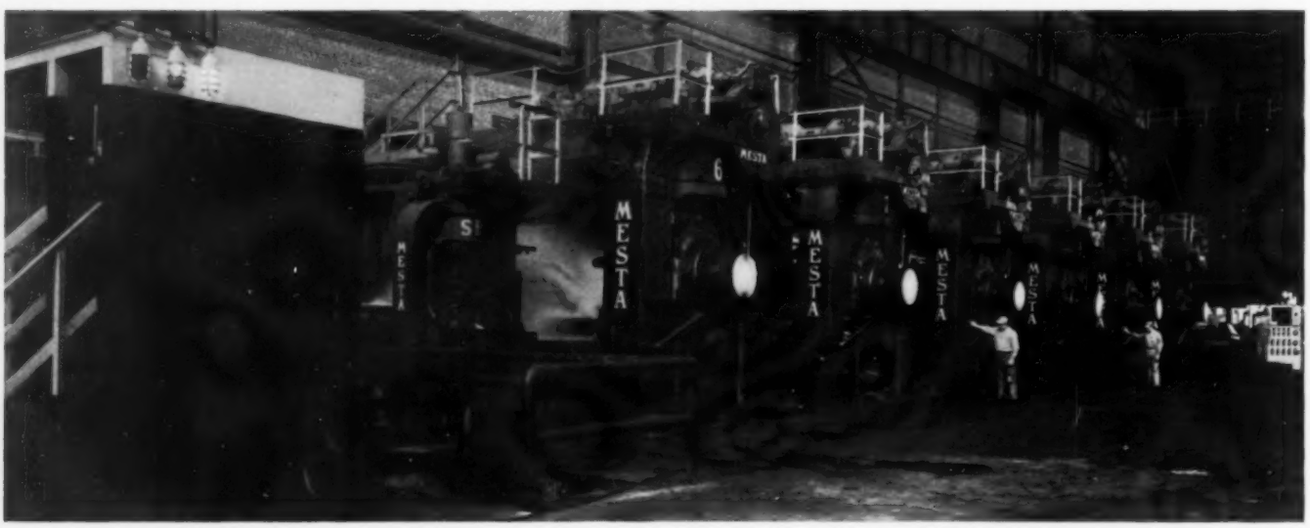
A transfer car operates on a track running between the end of the mill table and the slab yard, providing means for returning slabs that have passed through the furnace back to storage.

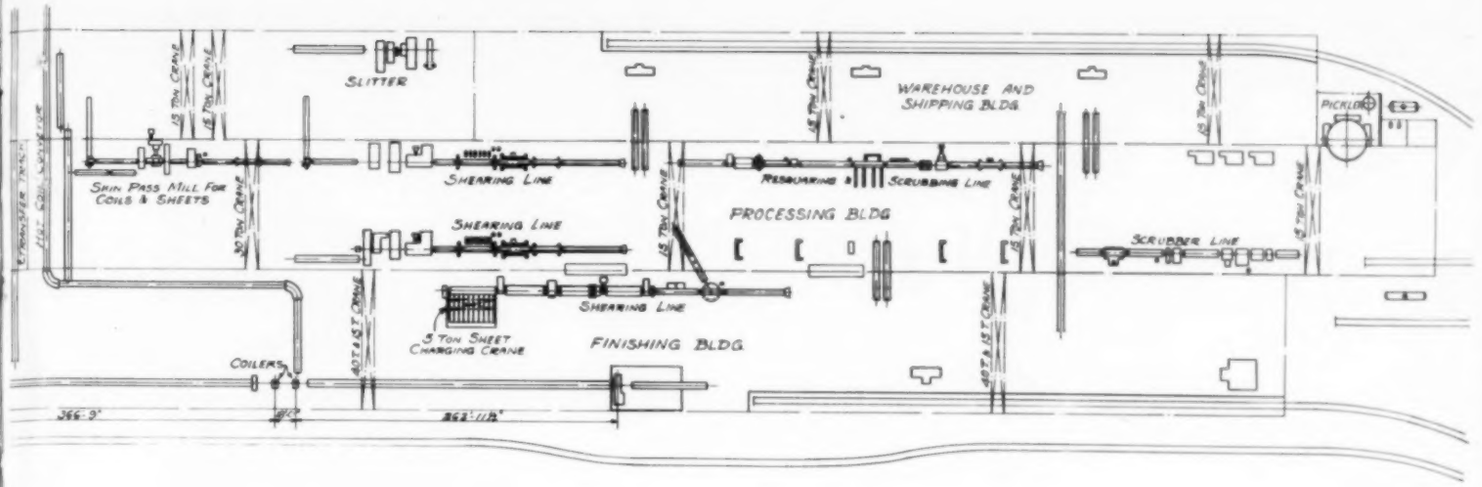
Passing over the approach table, the slab comes to the hot mill, the first unit of which is a vertical edger containing rolls 40 in. in diameter and driven by an 800-hp, 514-rpm, 440-volt, a-c motor. Next, at a distance of 31 ft 4 in., is the first roughing stand, a 2-high, 36 in. x 70 in. unit driven by a 2000-hp, 150-rpm, 6600-volt a-c motor. The next four roughers are 4-high stands, spaced, respectively, 37 ft 9 in., 59 ft 5 in., 89 ft 6 in., and 140 ft 6 in. from the preceding mill stand. These stands use 34-38 in. x 69 in. work rolls and 53 in. x 64 in. backup rolls. The first of the 4-high stands is driven by a 3500-hp, 144-rpm motor, the second by a 4500-hp, 257-rpm motor, and each of the next two by a 4500-hp, 400-rpm motor, all at 6600 volts a-c.

The last three roughers are equipped with integral vertical edging rolls, each pair driven by a 150-hp, 450-rpm, 230-volt d-c motor mounted on top of the mill housing and equipped with forced ventilation. Edger roll speed is synchronized with main roll speed.

No turntables, slab pushers or slab squeezer are in-

A 2-high scalebreaker and six 4-high stands form the finishing train of the 68 in. mill. A maximum delivery speed of 2120 fpm is available.





General layout of 68 in. hot strip mill.

stalled on the strip mill, as no broadside rolling is performed because slabs are available in widths up to the maximum rolled on the strip mill.

The mill table following the roughing train is 219 ft 11 in. long and is divided into 3 sections, each section driven by a 50-hp, d-c mill motor under variable voltage control. Power for these drives comes from two 200-kw motor-generator sets, one of which is a spare for this table and may also be used in emergencies on the finisher runout table.

A rotary crop shear is located at the end of the delay table just ahead of the finishing train. It is capable of cutting sections up to one inch thick and 62 in. wide.

Following this table is the finishing train, the first unit of which is a 2-high, 25½ in. x 68 in. scale breaker driven by a 500-hp, 150/600-rpm, 600-volt, d-c motor, and followed at a distance of 18 ft by the finishing train, consisting of six 4-high stands on 18 ft centers. These stands carry 27 in. x 69 in. work rolls and 43 in. x 64 in. backup rolls, and are driven by 600-volt, d-c motors. The first five drives are 4000-hp, units, and the fifth is a 3500-hp unit. Speeds of these motors are, respectively: 125/250, 125/250, 80/160, 100/200, 125/250 and 150/300 rpm.

Loopers, to take up any slack in the strip, are located between the successive finishing stands. They are actuated by torque type d-c motors controlled from a special motor-generator set.

Screwdowns on the 2-high rougher are driven by a single 50-hp, d-c mill motor and those on the finishing scale breaker by two 7½-hp, d-c mill motors. On all other stands, two 75-hp, d-c mill motors are used, with magnetic clutches to allow operation of the screws separately or in unison.

All 4-high stands are provided with roller bearings on work roll necks and oil-film bearings on backup roll necks. Roller bearings are used on the roll necks of the vertical edger, while composition bearings are employed on the 2-high rougher and the finishing scale breaker. All pinion stands and gear sets operate with babbitted bearings with the exception of those on the finishing scale breaker, where roller bearings are applied.

Lubrication for the entire hot mill is provided by circulating oil systems and automatic and manual grease systems. The oil systems are as follows:

1. 12,000 gal storage, 300 gpm, serving 28 bearings on the main drive gear sets.
2. 12,000 gal storage, 500 gpm, serving 44 bearings on the pinion stands.
3. 24,000 gal storage, 400 gpm, serving 40 bearings on back-up roll necks.
4. 4000 gal storage, 90 gpm, serving 50 bearings on the main drive motors.
5. 500 gal storage, 25 gpm, serving 12 bearings on the vertical edger.

In the first three of these systems, a straight mineral

Each of the two down-coilers is driven by five 20 hp d-c motors under adjustable voltage control. Coils can be produced up to 52 in. outside diameter.

The hot mill motor-room, 800 ft long, houses all main drive motors, gear sets, motor-generator sets, and control equipment for the 68 in. mill.

oil, with a viscosity of 2450 seconds Saybolt Universal at 100 F, is used. A mid-continent base, oxygen-inhibited mineral oil, with a viscosity of 312 seconds Saybolt Universal at 100 F, is used on the motor bearings, while the edger is supplied with the same type of oil but of 559 seconds Saybolt Universal at 100 F.

The first four systems include pressure filters and bypass centrifuges.

Single-line automatic measured systems provide grease lubrication where required on the hot mill stands, a total of 282 points. Single-line manual systems serve more than 2200 points around the furnaces and along the mill tables. A single-line system with automatic pump serves approximately 256 points on the two hot strip coilers. In all of the grease systems, lime-soap grease is used with a worked consistency of 285-315 and carrying a steam refined cylinder stock.

Good surface on the finished strip is insured by single hydraulic descaling sprays on No.1, 2, 3 and 5 roughers and a double spray at the entrance to the finishing train. The spray valves are pneumatically operated under solenoid control. Water is supplied to the sprays at 1250 psi pressure by three centrifugal 1250-gpm pumps each driven by a 1250-hp, 6600-volt, a-c motor. A pneumatic accumulator is installed in this hydraulic system. Steam jet blowers are also placed at each of the five roughing stands for further surface protection.

Gear ratios and mill speeds are as follows:

Stand	Motor, rpm	Gear ratio	Roll, rpm	Strip speed, fpm
Vertical edger	514	28.56	18	188.5
No. 1 rougher	150	7.5	20	188.5
No. 2 rougher	144	5.89	24.45	243.2
No. 3 rougher	257	7.5	34.27	340.9
No. 4 rougher	400	7.5	53.34	474.7
No. 5 rougher	400	7.5	53.34	474.7
Scale breaker	150/600	9.3	16.1/64.5	107/430
No. 6 finisher	125/250	4.24	29.5/59.0	208/417
No. 7 finisher	125/250	2.57	48.6/97.2	343/687
No. 8 finisher	80/160	Direct	80/160	565/1130
No. 9 finisher	100/200	Direct	100/200	706/1413
No. 10 finisher	125/250	Direct	125/250	883/1767
No. 11 finisher	150/300	Direct	150/300	1060/2120

As the steel progresses through the mill, its temperature is carefully checked by means of recording radiation pyrometers. One of these units is located over the mill table at the roughing train, and a second unit is installed between the last two finishing stands. Both of these units are connected to recorders on the furnace instrument panel and in the roller's pulpit. Radiation units are also located at the coilers and at the piler, both connected to a single recorder.

At the exit end of the finishing train is a hot flying shear, driven by a 900-hp, 300-rpm, 600-volt, d-c motor under electronic control and designed to cut the strip into any desired length between 16½ and 33 ft. From

the shear, the runout table extends for approximately 360 ft to two down-coilers and on 270 ft more to a piler, where plates cut to length by the flying shear may be piled. The runout table rollers are individually driven by 409 d-c motors rated at 4-hp, 0-750-rpm and operating adjustable voltage control. Water sprays along the runout table afford control of coiling temperatures.

Each coiler is driven by five 20-hp d-c motors, also under adjustable voltage control. Two motor-generators, each having three 300-kw, 250-volt generators, provide power for the coilers and runout table. One of these serves the table from the hot mill to coilers. The other serves either the coilers or the table between coilers and piler, depending on whether the product is going into coils or into cut lengths.

The hot mill averages 260-265 net tons rolled per hour, and has established records of 435 tons per hour, 2821 tons per 8-hour turn, 7577 tons per day and 135,451 tons per month. The product averages about 14.4 gage, with approximately one-half going to tinplate, one-fourth to full finished sheets, and one-fourth to hot-rolled product. Coils can be produced up to 52 in. diameter.

Approximately 57 kwhr per ton of product are used by the main roll drives, while hot mill auxiliaries consume another 40 kwhr per ton.

All main drive motors, gear sets, motor-generator sets, control equipment and switch gear for the hot mill are placed in a motor room 800 ft long x 65 ft 2 in. wide, running beside the hot mill building. This room is ventilated by a recirculating system, with air being drawn from the room down through the rotating machinery and passing on through air coolers and back into the motor room. The five roughing motors, however, have individual closed ventilating systems, each with its own fan, air cooler, etc. Three electro-static precipitators rated at 57,600 cfm each serve to clean make-up air before it is introduced into the system.

The synchronous motors driving the roughing stands are started by throwing them directly across the line. Finishing stand motors, operating on adjustable voltage control, receive power from three motor-generator sets, each consisting of two 6000-kw, 600-volt, d-c generators and one 8400-hp, 360-rpm, 6600-volt synchronous motor. A separate motor-generator set, composed of two 750-kw, 600-volt, d-c generators and a 750-hp, 720-rpm, 6600-volt synchronous motor, serves the flying shear.

Runout table motors are provided with power at adjustable voltages by two motor-generator sets, each with three 900-kw, 250-volt d-c generators driven by a 1250-hp, 1200-rpm, 6600-volt synchronous motor. The delay tables, which also operate on adjustable voltage control, receive power from two sets, each consisting of a 200-kw, 325-volt, d-c generator and a 300-hp, 440-volt induction motor.

The torque motors operating the finishing train loopers are served by two motor-generator sets, each comprised of a 25-kw, 50-volt, d-c generator and a 40-hp, 440-volt induction motor.

Alternating-current for the entire hot mill comes from two tanks of transformers, each rated at 15,000/20,000 kva, 34.5/6.9 kv. Seven other transformer banks, totaling 8000 kva capacity, reduce 6900 volt power to 460 volts for auxiliaries. Direct-current is provided by two 750-kw mercury arc rectifiers, which convert 6900 volt a-c to 250 volt d-c.

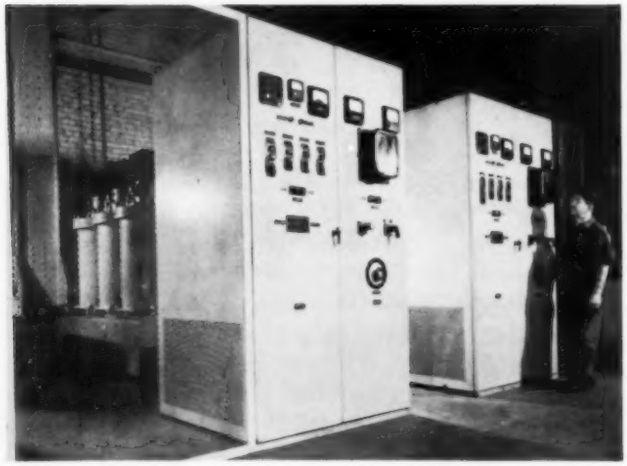
The hot strip mill, with its auxiliaries, makes a total primary connected load of 59,500 kva.

HOT FINISHING

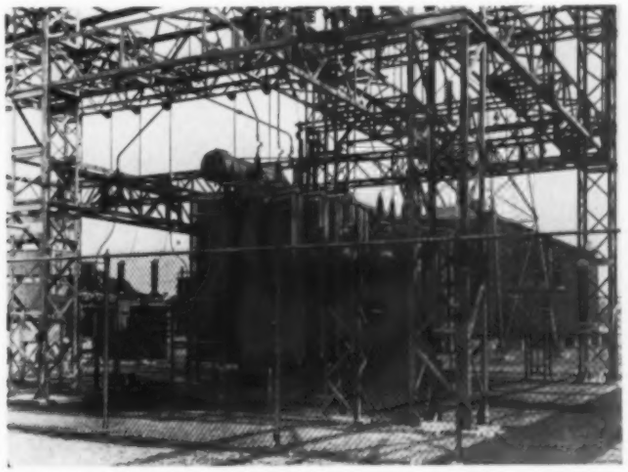
A complete layout of hot finishing equipment was installed in connection with the 68 in. hot mill. Conveniently located adjacent to the hot mill piler is a shearing line, consisting of a sheet charger, a leveler, a side trimmer, an up-cut shear, another leveler and a piler arranged so that it can deliver either into the end of the hot mill building or into the adjacent processing building. This line handles cut lengths of 5-30 ft, in widths of 18-60 in. and gages 0.09-0.25 in., at speeds of 125-370 fpm. The line has a capacity of 20 tons per hr.

Coils ejected from the hot mill coilers are taken by the hot coil conveyor into the adjacent processing building or, if desired, on to new cold mill facilities. In the processing building is a 2-high, 32 in. x 68 in. skin pass mill driven at 73-146 rpm by a 300-hp, 500-1000-

Each of these control cubicles operate a 750 kw rectifier which converts 6900 volt alternating current to 250 volt direct current for mill auxiliaries.



Power for the new strip mill comes from this outdoor substation which contains two 15,000 kva, 34.5/6.9 kv transformers.



This 2-high 32 in. x 68 in. skin pass mill, located in the hot finishing department, is designed to handle either coiled material or cut lengths.

rpm, 600-volt, d-c motor. Power is supplied to this motor by a 620-kw motor-generator set. Roller bearings are applied to roll necks, pinion stand and gear set. Feed and tension reels are provided for handling coils, while a sheet charger, leveler, and piler make the mill adaptable for sheets up to 20 ft long as well. The unit is designed to handle widths of 18-60 in. and gages of 0.047-0.250 in., at speeds of 615-1230 fpm. It has a nominal capacity of 75 tons per hr.

Two shearing lines are installed nearby, each consisting of a processing uncoiler, side trimmer, rotary shear, leveler and piler. Each unit is rated at 25 tons per hr, and operates at speeds of 100-600 fpm, cutting

Two new continuous pickling lines process strip from the 68 in. mill before the material passes on to the cold reduction mill.

coils of 18-60-in. width and 0.047-0.187 in gage lengths of 3-20 ft.

This department also contains a four-arm plunger type batch pickler, a scrubbing-leveling line, a resquaring-scrubbing line, a slitting line, oiling machines, and four resquaring shears.

COLD SHEET EXPANSION

For coils destined for cold reduction, pickling facilities are provided by two new continuous lines of about 665 ft overall lengths, with a total capacity of about 75,000 tons per month. Each line consists of a coil feeder, a pinch-roll processor, an up-cut squaring shear, a stationary-die flashwelder and weld trimmer, a stitcher, a looping pit, five acid tanks, two rinse tanks, a dryer, a shear and a recoiler. The looping pits are 35 ft in length, of concrete construction with wooden bottom, and are provided with side guides adjustable in accordance with strip width.

Acid tanks are 60 ft long, 6 ft 6 in. wide and 4 ft deep, and are of welded steel plate construction, lined with ¼ in. of rubber and finally with 8 in. of brick. Water tanks are of similar construction but of 25 ft length. Tank covers are also of steel construction, rubber lined, and are vented to the outside through lead-lined exhaust fans.

Pickling solutions, which are maintained at 205-210 F by live steam jets under automatic temperature control, normally contain about 12 per cent sulphuric acid, and the solution is cascaded back to No. 1 acid tank, from which it overflows. Pickling loss for all gages processed average 0.8 per cent.

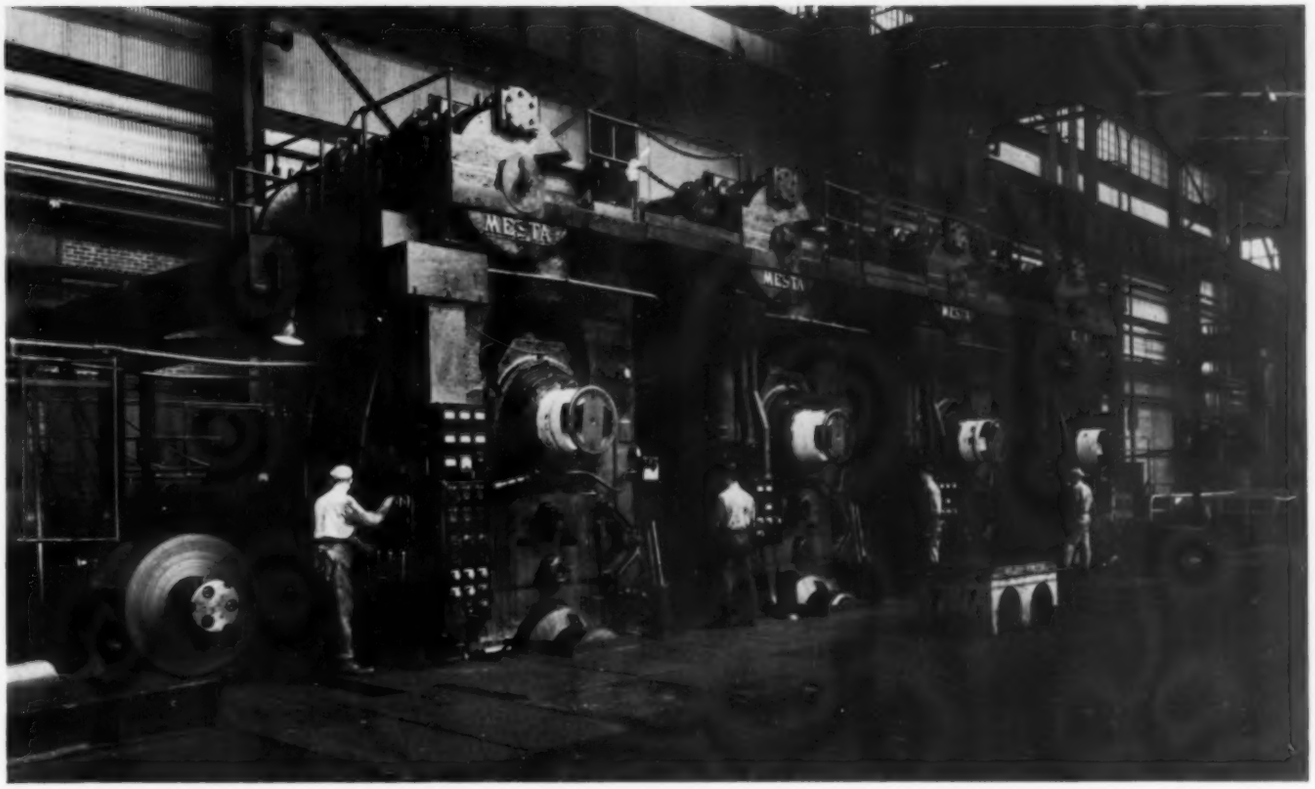
Both lines operate under adjustable voltage control, the entry ends at speeds up to 800 fpm and the delivery ends up to 400 fpm.

The new cold reduction mill, which was put into operation January 17, 1947, consists of four 4-high stands spaced on 14 ft centers. Work rolls, of forged steel, are 21 in. x 56 in., with cast steel backup rolls 56 in. x 51 in. The first stand is driven by a 2000-hp motor. the second by a 2500-hp motor, and the third and fourth stands each by two 1500-hp motors in twin-drive arrangement, all of 750 volts d-c. These motors receive power from a motor-generator set composed of two 4000-kw, 750-volt generators driven at 300-rpm by an 11,200-hp synchronous motor. Mill screws on each stand are driven by two 50-hp d-c mill motors, connected by magnetic clutches.

Speeds of these stands are as follows:

Stand	Motor, rpm	Gear ratio	Roll, rpm	Strip speed, fpm
No. 1	70/175	1	70/175	405/963
No. 2	130/260	1	130/260	715/1430
No. 3	200/450	0.913	182/410	1004/2259
No. 4	200/500	1.095	219/547	1205/3013

Roller bearings are applied on all work roll necks, pinion stands and gear sets of this mill, while oil film bearings are used on the backup roll necks. Automatic systems are used for oil and grease lubrication as required. The expanding mandrel reel, equipped with



This 56 in. cold reduction mill, consisting of four 4-high stands on 14 ft centers, has a maximum delivery speed of 3013 fpm.

belt wrapper, is driven by two 300-hp, 375-volt, 300-1200-rpm, d-c motors.

Coils from the hot mill come to the cold mill in various widths and gages, approximately as follows:

Width, in.	Per cent
18-24	5
24-30	35
35-42	40
42-49	20

Gage, in.	Per cent
0.076	32
0.080-0.085	30
0.030-0.109	36
Over 0.109	2

Flying micrometers provide a constant check on the gage of the product, and the mill is equipped with instruments showing speed and tension of the strip.

Reduction in cold rolling may total 45-90 per cent, and averages about 70 per cent. Approximately 50 kwhr is consumed per ton of strip.

This mill has a nominal capacity of 56,000 tons per month, and can roll strip down to 28 gage in widths up to 40 in., and to 31 gage in widths up to 36 in. The product goes principally to full finished sheets, with about 33 per cent to tinplate and 15 per cent to galvanized sheet.

Annealing capacity for the cold mill expansion is furnished by 26 direct-fired cover-type furnaces 24 ft ½ in. long x 9 ft 6½ in. wide inside. The covers are fired by a 500 Btu per cu ft mixture of coke oven and blast furnace gas through inspirating burners.

Furnace bases, of which there are 80 installed, are of two types: plain flat bases for sheet packs and those equipped with recirculating fans for coils. Sheets can be accommodated in packs up to 60 in. high in inner covers 88 in. wide. Coils up to 70 in. diameter may be piled to a maximum height of 9 ft 4 in. Cylindrical inner covers are 76½ in. in diameter. Of the 80 bases, 19 are for flat products, 43 for coils, and 18 are interchangeable for either coils or flat material.

Annealing temperatures, automatically controlled, normally range 1280-1320 F, and fuel consumption averages 1,180,000 Btu per ton. Furnace charges average about 125 tons. Protective atmosphere is provided from a central station containing units for the production of a partially burned gas of reducing characteristics.

Two skin pass mills are installed for rolling annealed product to the desired temper and surface finish. These are duplicate 4-high single stand units, with 21 in. x 56 in. work rolls and 56 x 51 in. backup rolls. Each stand is driven direct by two 400-hp, 350-volt, d-c motors in twin drive arrangement. Both of these mills are equipped with pay-off and tension reels, and one is also provided with sheet handling facilities. The mills operate at speeds of 600 fpm on sheets and up to 3300 fpm on coils. A single motor-generator serves both of these mills, with one 650-kw generator for each mill drive and one 500-kw generator for each reel drive. The average reduction in temper rolling is ½-¾ per cent.

This department also includes four classifying shear lines and one gang slitter, all capable of handling 14-32 gage material in widths of 18-62 in. The rotary shear lines operate at speeds up to 600 fpm, and produce lengths of 2-20 ft. The units average 17.5 tons per hr for the overall product mix.

A 60 in. sheet galvanizing line was also installed, cap-

Twenty-six direct-fired annealing covers, with 80 bases, provide annealing capacity for coils and cut lengths from the new cold mill.

able of coating sheets from 18 x 65 in. up to 52 x 160 in. The line is 101 ft 2¾ in. long overall, and contains, consecutively, a sheet feed table, muriatic acid bath, galvanizing pot and machine, spangle conveyor, cooling table, pinch rolls, roller leveler, sheet washer, squeezer rolls, dryer table, roller leveler and piler table.

The galvanizing pot, 93 in. wide x 136 in. long x 60 in. deep, is heated by 500 Btu per cu ft gas burned through seven inspirating gas burners. Approximately 700,000 Btu are consumed per ton of product.

Sheets may travel through the line at speeds ranging 10-90 fpm, depending on their gage. Coating weight averages 100 lb per ton of product. The line will produce up to 14.5 tons of coated sheet per hour.

This unit brings the number of these machines to nine.

TINPLATE MODERNIZATION

The first electrolytic tinning and fusion line at Sparrows Point began operation February 5, 1943. Two additional installations were put into operation in April and October of the same year. These three continuous lines, of the alkaline type, operate at speeds of 450-900 fpm. The overall length of these lines is 140 ft from feed reel to tension reel, although there is actually a strip length of 1700 ft in the line between the same points.

The entering coil, paid off the feed reel at speeds up to 1100 fpm, passes through a double-seam welder and into a looping tower which permits a vertical travel of 37 ft for each of the 12 lengths of strip in the tower.

Next, the strip passes through a 5000 gal, rubber lined acid tank, where it receives a light pickle, then through a rinse tank, and on into the plating tank, which is 56 in. wide x 12 ft 6 in. high x 54 ft long. On both cases, the strip travels in vertical loops over and under rollers along the top and bottom of the tanks.

Tin anodes 28 in. wide, 6 in. thick and about 9 ft long are suspended between each two successive vertical strands of strip. The plating bath, which is delivered to the plating tanks by centrifugal pumps from two 25,000 gal storage tanks, contains 12-15 grams of sodium hydroxide and 35-50 grams of tin per liter. The electrolyte is filtered and reused.

Electrical current for plating is supplied to one line by selenium rectifiers with a total capacity of 60,000 amp, while the other two lines are supplied from motor-generator sets totaling 120,000 amp in capacity. Voltage is normally maintained at nine. Power consumption averages about 50 kwhr per ton of product.

Next in line is a rinse tank, followed by drying equipment consisting of a steam chest with hot water and wringer rolls. Finally, the strip passes through pinch rolls, a looping tower duplicating that on the entry end, another set of pinch rolls, and to the tension reel, which is driven at speeds up to 1100 fpm by a 40-hp, d-c motor. The strip is cut apart manually at the coiler.

Each plating line averages about 20 tons production per hour, with coils averaging about 10,000 lb in weight.

Before coils are put through the electrolytic tinning lines, they are put through one of two trimming lines, where the coil edges are trimmed off. Thus, the waste of tinning material destined to be scrapped is avoided, as well as the troublesome problem presented by tinned scrap.

The brightening operation is performed in separate continuous units, of which there are six. From the feed reel, strip passes at speeds up to 600 fpm through a double-seam welder, and a looping tower 27 ft high.

Then follows a cathodic precleaner, using trisodium phosphate and a current density of 10-20 amp per sq ft at a voltage of about 12.

The strip next travels through a hot rinse tank , and then through a fusion furnace, a vertical unit in which the strip makes one vertical loop about 35 ft high. The strip first passes up through a preheating zone, where air heated by the hot waste gases expelled from the heating zone is recirculated. Next, the strip passes down through the heating zone between two vertical rows of radiant tube heating elements. Each heating element has two horizontal firing legs that are connected by return bends. The bend on one end of each element contains a gas burner and an exhaust connection. There are 17 heating elements, or 34 firing legs, in each vertical row. The elements are made of heat-resisting alloy (25 per cent chromium, 12 per cent nickel), with the firing legs 5 in. inside diameter and 5½ in. outside diameter.

The strip presents 320-360 sq ft of surface to the radiant heating tubes, and the rate of heat transfer is about 2200 Btu per hr per sq ft of strip surface.

Coke oven gas, mixed in an industrial carburetor

Sheets from 18 x 65 in. up to 52 x 160 in. are galvanized in this 60 in. unit, which has a capacity of 14.5 tons of coated sheet per hour.

with proper amount of air for complete combustion, is burned inside of the tubular heating elements. The temperature of the tin coating must be raised to about 450 F for reflow to occur. This condition is obtained by automatically controlling furnace temperature at 1175-1300 F at a point 5 ft from the furnace exit. Strip speed ranges 275-350 fpm. Fuel consumption averages 600,000 Btu per ton of product.

This brightening operation was discussed in detail by H. L. Halstead, "Tin Fusion by Radiant Tube Heating," AISE Proceedings 1945.

Leaving the furnace, the strip receives a water quench and a chromic acid dip, and then passes through a steam condensate rinse, a dryer, a vertical branner and a looping tower, and finally, to a tension reel.

The brightening lines are 100 ft long overall.

Another improvement made in the tin plate department was the conversion of an existing single-stand skin pass mill to a two-stand tandem unit capable of speeds up to 3675 fpm. The first stand of this mill uses forged steel work rolls with bodies 12 in. in diameter x 42 in. long, and cast alloy steel back-up rolls with bodies 53 in. in diameter x 42 in. long. The second stand, 13 ft distant, uses 19 in. x 42 in. work rolls and 49 in x 42 in. back-up rolls.

The drives of this mill are unusual in that the work rolls of the first stand are idlers, while the back-up rolls are direct driven by two 300-hp, 200-300-rpm, 600-volt d-c motors in a twin drive arrangement. On the second stand, each work roll is driven by two 200-hp, 575-750-rpm, 300-volt d-c motors, arranged in a direct double motor twin drive. Two motors were necessary on each roll because of space limitations. Forward and back tension rolls mounted on the face of the mill housings are direct connected through universal spindles to 400-hp, 600-750-rpm d-c motors.

Power for all motors of the skin pass mill is supplied by a 1750-kw, 600-volt generator driven by a 2500-hp, 6600-volt motor. This set, as well as the mill motors, are cooled by forced ventilation provided by circulating blowers.

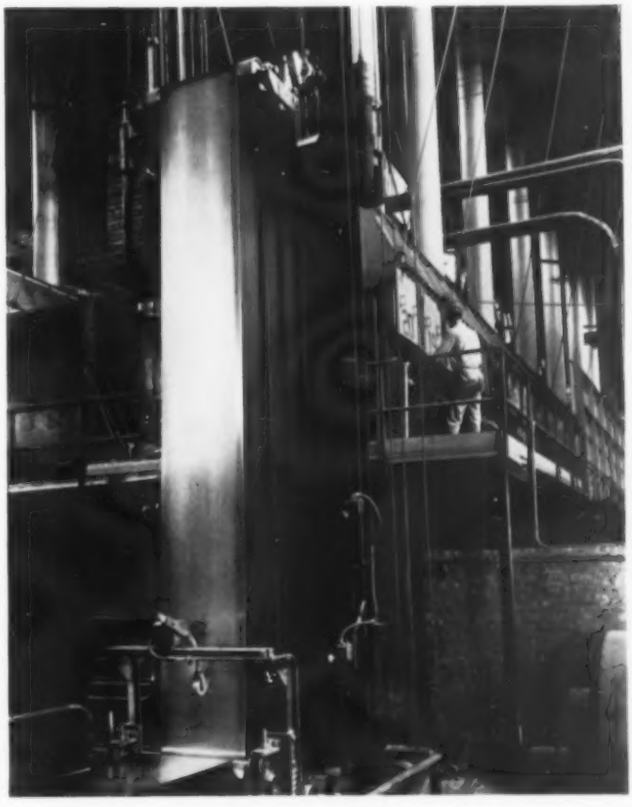
Work rolls and tension rolls are equipped with roller bearings, lubricated by an automatic pressure grease system. Back-up rolls run in oil-film bearings lubricated by a fully automatic pressure system.

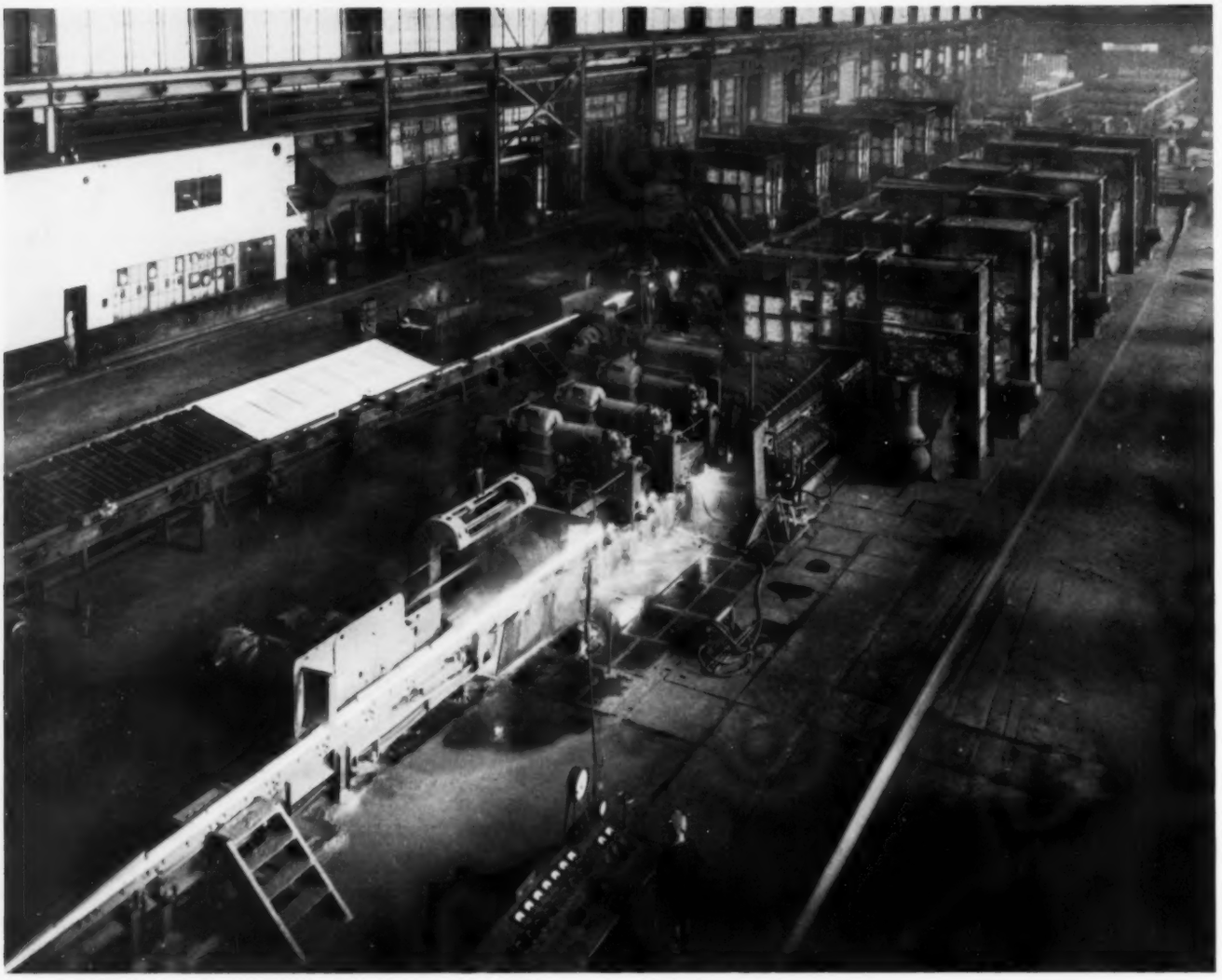
The mill has an average output of 41 tons per hr.

PIPE MILLS

Pipe producing facilities were modernized in 1940 by the installation of two continuous butt-weld pipe mills.

This view shows the looping tower on the entry end of an electrolytic tinning unit. Each of the three units, which are of alkaline type, produces about 20 tons of tinplate per hour.





These two continuous butt-weld pipe mills, which produce pipe ranging ½-4 in. in diameter, replaced two old style butt-weld mills.

One of these is designed to produce pipe in diameters ½ to 1¼ in., while the other handles diameters of 1½ to 4 in. Both follow the conventional pattern of such units, consisting of an uncoiler, a leveler, a shear, a flash welder and trimmer, pinch rolls, looping bed, pinch rolls, furnace, forming mill, hot saw, runout table and cooling beds.

For the smaller mill, the welder is a 200-amp, 4-10 volt unit that forms welds in 15-30 seconds. The looping bed provides for a primary loop of 175 ft and a secondary loop of 50 ft. The furnace, which is fired with a mixed gas of 500 Btu per cu ft, is 143 ft long x 2 ft wide, and is equipped with three recuperators. Fuel consumption averages 6,000,000 Btu per ton of product. The six-stand forming mill is driven by a 30-hp d-c motor at speeds up to 500 fpm. The hot saw, with a blade 22 in. in diameter, is driven at 3600 rpm by a 5-hp motor. Following the saw is a 50-ft runout table, from where the pipe is carried over a cooling rack to a parallel table which leads through a descaler to a second cooling rack. Production from this mill averages 15½ tons per hr.

The larger mill has practically the same layout as the small one, but with some of the units somewhat larger. The welder is a 500-amp, 4.3-12.5 volts which joins the two skelp ends in 30-90 seconds. The recuperative furnace is 154 ft long x 2 ft 6 in. wide, and consumes 4,600,000 Btu per ton of pipe produced. The six stands of this forming mill are individually driven at speeds up to 290 fpm, each stand by a 20-hp d-c motor under adjustable voltage control. On this unit the hot saw contains many design features originated by Bethlehem personnel. It has a 26 in. diameter blade driven at 3450 rpm by a 10-hp motor. The remainder of the unit practically duplicates the No. 1 mill. This mill produces an average of 27 tons per hour.

The control schemes for both mills are similar, with the second pair of pinch rolls, the mill drive motor and the saw carriage motor operated as a unit under adjustable voltage control. A motor-generator set serves each mill, one of 75 kw capacity on the small mill and one at 40 kw on the large mill. The first pair of pinch rolls, conveyor, rack and descaler receive power from the plant d-c system. Both mills consume about 15 kwhr per ton of product.

With the installation of these mills, two old style-butt-weld pipe mills were removed. Two lap-weld pipe mills, however, are still in operation, producing pipe 3½-16 in. in diameter.

ROD AND WIRE

Rod and wire production was also stepped up. No. 1 rod mill, which was built in 1926 as a two-stand mill, was converted to three-stand operation in 1947. This mill consists of seven 12 in. roughing stands and ten 10 in. finishing stands, all in a straight line and all driven through gearing by a single 4000-hp, 6600-volt, 375-rpm (370.48 rpm loaded), 25-cycle motor.

When the mill was changed to three-stand, some gear changes were made, and the mill set-up is now as follows:

Mill stand	Roll, rpm
0	13.747
1	20.4
2	38.62
3	55.536
4	77.75
5	105.5
6	149.15
7	239.38
8	309.85
9	391.85
10	491.1
11	587.33
12	718.89
13	844.7
14	968.47
15	1077.76
16	1195.25

Billets, 2 in. x 2 in. x 30 ft, are rolled down to rods ranging from No. 5 to ½ in. diameter. In the roughing train, reductions are generally squares to diamonds or to ovals, and range 20-40 per cent per pass. The finishing train employs oval-round reductions ranging 12-20 per cent per pass.

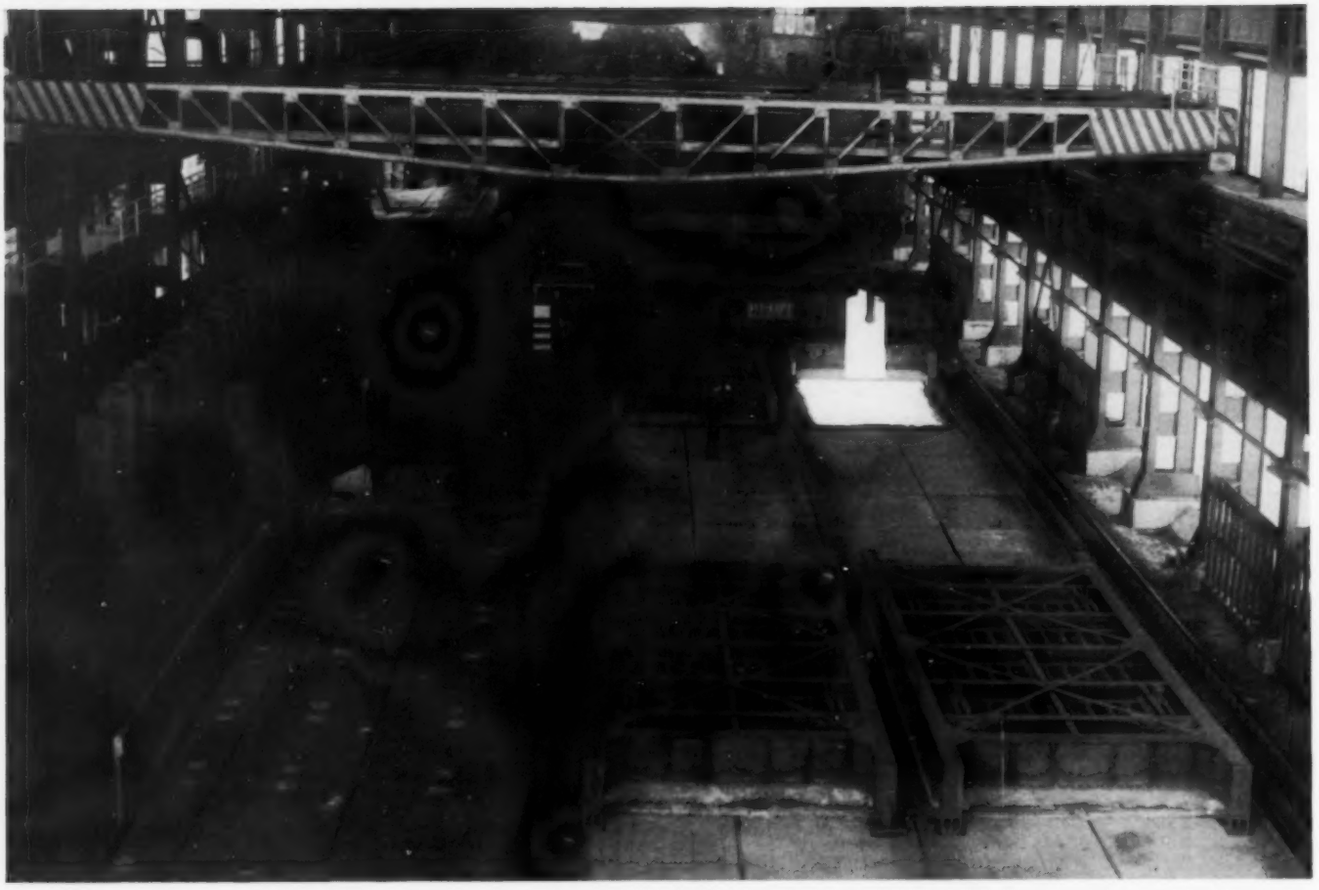
Leaving the mill at a speed of 3489 fpm, the rods pass on to four 34 in. enclosed laying reels which are driven through gears from the main mill drive.

The addition of the third strand has increased the production of this mill about 50 per cent, the hourly rate now averaging 32.5 net tons.

The productive capacity of No. 2 rod mill was also increased materially by the installation of a second finishing train. As originally installed in 1937, this combination rod and bar mill was designed to roll billets 30 ft long and up to 3 in. square into rods ranging from No. 5 to $^{47}/_{64}$ in. diameter or into bars $^{3}/_{8}$ to 1 in. in diameter. The mill consisted of nine roughing stands, four intermediate stands, two looping stands and six 10 in. finishing stands. The setup for these stands was as follows:

Stand No.	Distance from preceding stand, ft-in.	Gear ratio	Motor, hp	Motor, rpm
0		30.1622		
1	5-11.32	24.000	500	250/750
2	6-0	18.27067	300	250/750
3	6-0	7.67958		
4	5- 9.63	5.19501		
5	5-10.73	3.68254		
6	5- 6.98	2.36734	1500	150/450
7	5- 0.96	1.76762		
8	4- 7.92	1.35971		
9	23- 6	3.03448		
10	4- 6.46	2.41379	700	300/900
11	5- 0	1.90244		
12	4- 8.48	1.56097	700	300/900
13	.....	1.0	700	225/625
14	.....	1.0	700	300/625
15	.....	1.01835		
16	3- 3	0.84404		
17	3- 3	0.7500	1250	500/750
18	3- 3	0.65833		
19	3- 3	0.56557		
20	3- 3	0.49593		

Wire drawing facilities include 59 continuous wire drawing machines and 66 single or double deck blocks. Approximately 35,000 net tons of wire and rod are drawn per month.



These soaking pits, of reversing, regenerative design, are some of those installed to increase heating capacity for the blooming and slabbing mills.

All of the drive motors are rated at 600 volts, but operate on adjustable voltage provided by a motor-generator set.

The addition of the second finishing train, duplicating the original stands No. 15, 16, 17, 18, 19 and 20, with two pouring reels, four laying reels and the necessary conveyors, enabled the mill to roll four strands instead of two, and increased the production of No. 5 rod from 25 tons per hr to 45 tons per hr. For larger sized rods, the rate is 60-70 tons per hr. Bar production ranges 25-70 tons per hr, depending on the size produced.

Expansion of rod mill capacity necessitated accompanying expansion of wire and rod finishing equipment, which now includes 59 continuous wire drawing machines and 66 single or double deck blocks. Low and high carbon steel is drawn into gages ranging 0.035-0.625 in. diameter. The total draw of wire and rod is about 35,000 net tons per month. All drawing is dry, through tungsten carbide dies.

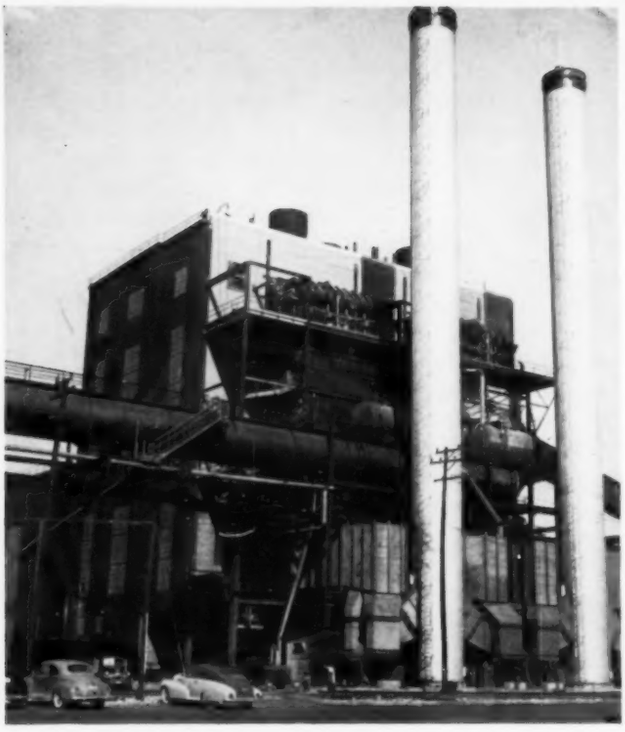
Three lines of flash bakers have been installed during the past 10 years, as well as another bethanizing unit, wherein wire is given a heavy, durable coating of pure zinc in a continuous, electrolytic process developed at this plant.

Among the numerous improvements are several installations of furnaces to enlarge heating capacities at several mills, thus making it possible to turn out better products more economically. At the 40 in. slabbing mill, heating facilities were expanded by the installation of three rows of soaking pits, each containing four pits 12 ft long, 7 ft wide and 8 ft 6 in. deep. These pits are regenerative, with 7450 sq ft of heating surface in the checkers of each pit, and are fired with a mixture of blast furnace and coke oven gas averaging 105 Btu per cu ft. Fuel consumption averages 1,050,000 Btu per ton, with about 85 per cent of the ingots charged hot, and each pit heats approximately 5.6 tons per hr.

At the 56 in. hot strip mill, a fourth slab heating furnace was installed in 1945. This unit, 86 ft long overall and with a hearth width of 18 ft, is of the conventional triple-fired design, with 10 burners serving the top zone of the main heating section, 8 burners on the bottom zone, and 8 more on the soaking zone. These are combination burners, which can be switched from steam-atomized fuel oil to 500 Btu mixed gas as required. They have a total maximum capacity of 770 gal of oil or 225,000 cu ft of gas per hr.

Two tile recuperators preheat the air for combustion to 500-600 F, and reduce the temperature of the waste gases from 1400-1500 F to 800-900 F. Air for combustion comes from a single 42,000 cfm fan.

Each of the three firing zones is provided with automatic control on fuel input and fuel-air ratio, and temperature control is applied to the main heating zone and the soaking zone. Furnace pressure is also automatically controlled. When this furnace was installed, its controls and instruments, together with those of the three previously existing furnaces were moved to one central control house. This move, with the new set-up, was described in detail by C. E. Duffy, "Remote



Pennwood power station, just completed, burns coke breeze and blast furnace gas. The addition of this station increased generating capacity to a point where about 80 per cent of the power requirement is generated at the plant.

Control of Continuous Slab Heating Furnaces," AISE Proceedings, 1947.

This furnace adds a heating capacity of 73 net tons per hr to the previously existing three furnaces.

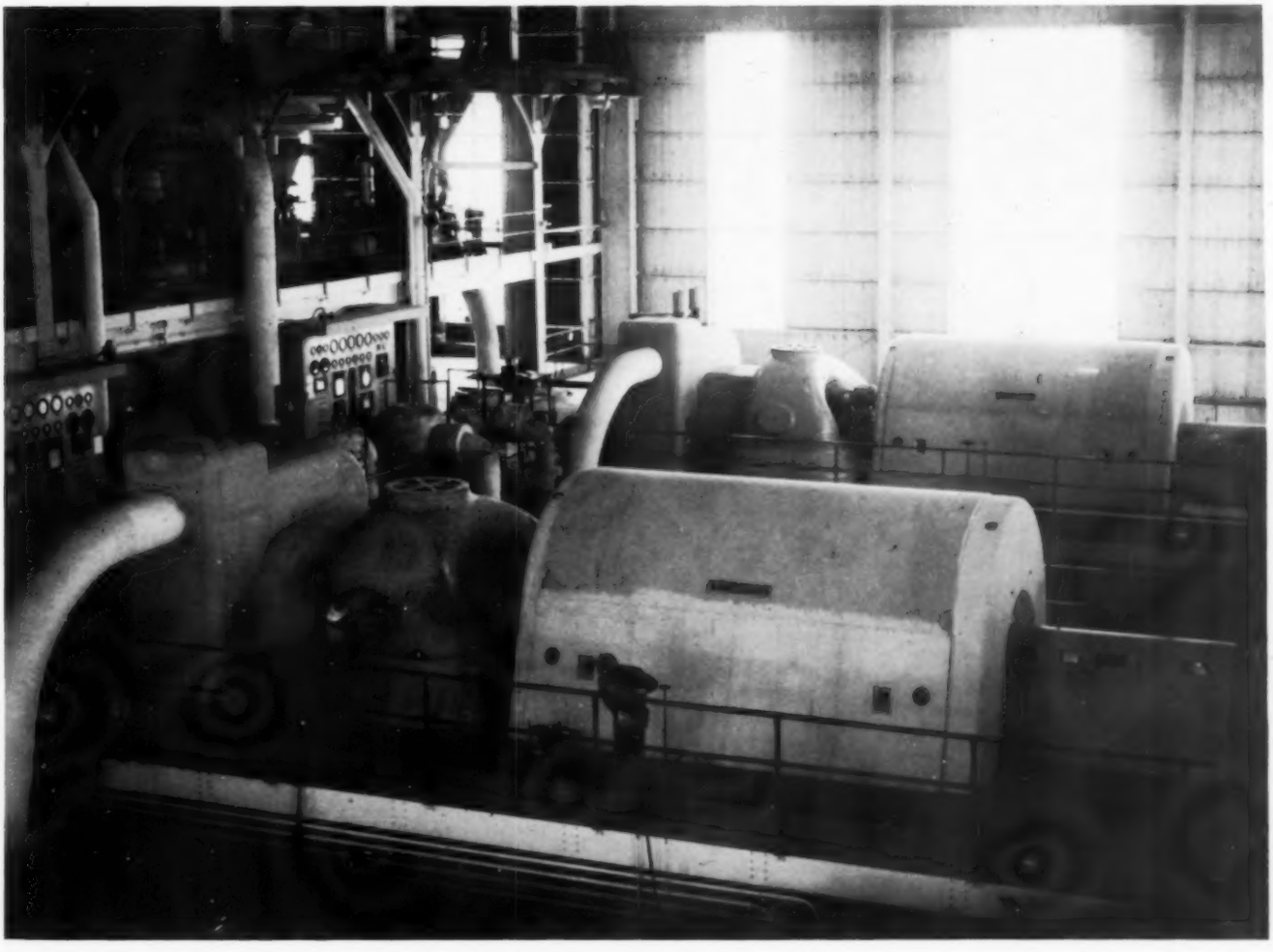
More recently, four rows of pits were added to serve the 40 in. blooming mill. Each of these rows contains two pits 20 ft long, 9 ft 3 in. wide and 9 ft 9 in. deep. Regenerative heating surface in these units totals 17,340 sq ft per pit. Mixed blast furnace and coke oven gas, averaging 135 Btu per cu ft, is used in these pits, and fuel consumption runs about 960,000 Btu per ton of ingots. Each pit will heat approximately 10 tons per hr. Pit covers for this installation are handled by two cover cranes.

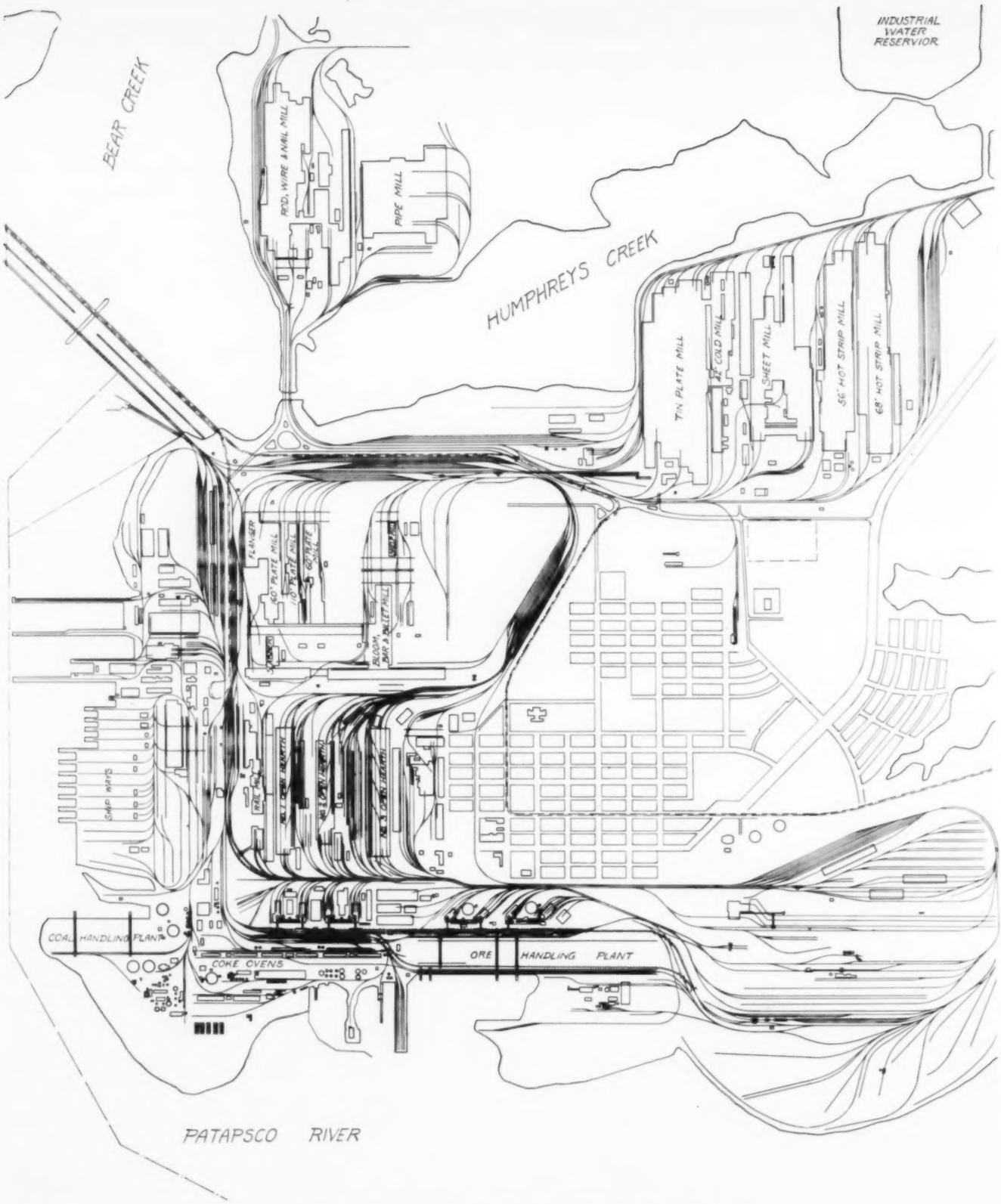
These pits were installed in an extension on the eastern end of the existing soaking pit building.

A similar step was taken at the 160 in. plate mill, where a fourth heating furnace was installed to increase heating capacity. This furnace is a side-door, reversing, regenerative unit, 42 ft long x 10 ft 4 in. wide inside. Fuel oil is burned through three water-cooled, steam-atomizing burners that come down through the roof directly over the bridge wall at each end of the furnace.

This furnace is completely equipped with automatic controls for furnace reversal, furnace pressure, temperature, and fuel-air ratio.

Pennwood power station contains two 30,000 kw condensing, hydrogen-cooled turbo-generators, operating on 850 psi, 900 F steam and generating power at 13,800 volts, 60 cycle.





General plan of Sparrows Point plant, Bethlehem Steel Company.

A complete description of this furnace was given by A. J. Fisher, "Plate Mill Heating Furnaces," AISE Proceedings, 1944.

PLANT SERVICES

A new power station, just completed, increased generating capacity materially, and improved the overall heat balance of the plant. This station contains two 400,000 lb per hr boilers operating at 900 psi, 900 F. Each boiler contains 26,660 sq ft of heating surface, 10,515 sq ft of water wall surface, 11,400 sq ft of superheater surface, 12,860 sq ft of economizer surface, and 45,500 sq ft of tubular air preheaters.

The boilers are fired with coke breeze on traveling chain grate stokers and with blast furnace gas or fuel

oil through combination burners. A combustion volume of 34,500 cu ft is provided in each unit.

Some steam from these units is put through pressure reducing valves and desuperheaters, and then flows into the 275 psi system feeding turbo-blowers, etc.

Power is generated by two 30,000 kw turbo-generators, each driven by a 29-stage, 850-psi, 900 F condensing turbine. A back pressure of about 1½ in. Hg absolute is maintained by single-pass, 25,000 sq ft surface condensers. Condenser water flows through a canal from the Patapsco River and is circulated through each condenser by two 22,500 gpm pumps. The water is treated by intermittent chlorination. Condensate pumps are rated at 800 gpm, 200 ft head. Water rate averages 8.65 lb per kwhr.

The generators are hydrogen cooled and are rated at 35,295 kva 85 per cent power factor. They operate at 13,800 volts, 60 cycles.

The installation of the new generators raised plant generating capacity to 114,000 kw. The equipment previously existing includes six 3000-kw gas engine sets, one 10,000-kw turbo-generator, and one 20,000-kw turbo-generator, all operating at 25 cycles.

At present, about 80 per cent of all power used is generated in the plant.

Originally, water for the Sparrows Point plant came from two sources. An unlimited supply was available from the river for all purposes where a chloride content approximately one-fourth that of sea water was permissible. Fresh water, available from artesian wells and conserved by cooling and recirculation, was used for all roll cooling applications, boiler feed, and sanitary purposes. Gradual depression of this fresh water table, however, coupled with infiltration of salt water, necessitated a new supply of fresh water. Accordingly, in 1942, after considerable investigation, an industrial water system was installed, based on the discharge from the sewage disposal plant of the city of Baltimore. At that time two clarifying tanks, each rated at 15,000,000 gallons per day, were put in, with flocculators and the other equipment necessary for feeding alum, which may range from none to 5 or more grains per gal, depending on the turbidity of the incoming water. Recently a third clarifying tank, of 20,000,000 gal per day capacity, was added, so that the plant now has a capacity of 50,000,000 gal per day.

Upon leaving this plant almost 5 miles away, the water is chlorinated so as to keep down algae growth in the 60 in. reinforced concrete conduit through which the water flows by gravity to a shallow reservoir near the steel plant. The only pumping station on this system, consisting of three centrifugal pumps totaling 40,000 gpm capacity, is located at the reservoir.

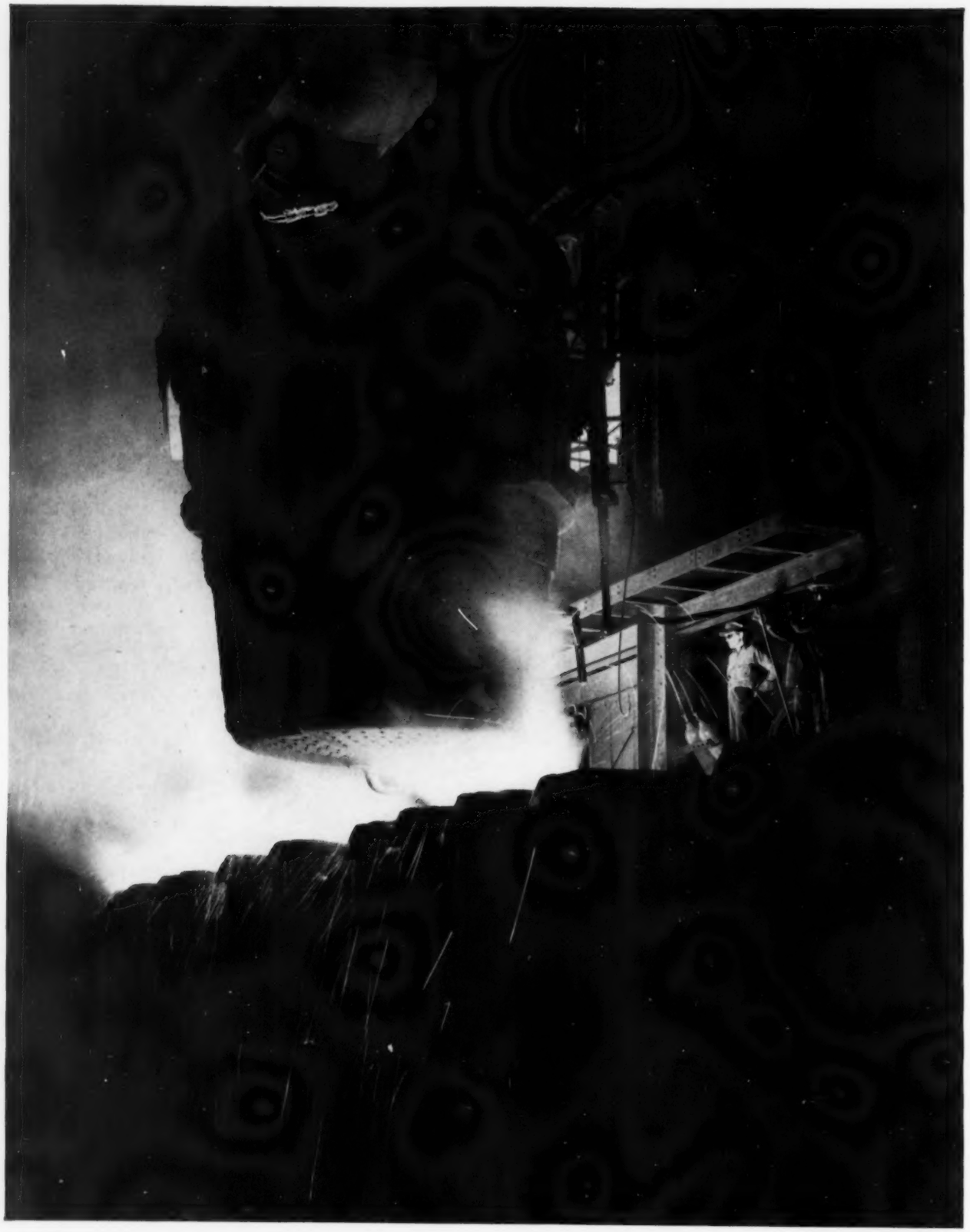
The original installation of this water system was described in detail by L. F. Coffin, "Reclaimed Sewage Water for Industrial Uses," AISE Proceedings, 1943.

Approximately 33,000,000 gal of water per day are used from this reclaiming system. The daily pumpage of salt water is about 170,000,000 gal, while that from the artesian wells is now 12,000,000 gal.

Another installation completed in 1948 is an oxygen plant capable of producing up to 7,000,000 cu ft of 99.5 per cent purity oxygen per month. This plant consists of a battery of four generators, giving considerable flexibility. A storage bank of 200,000 cu ft capacity is also provided to help balance production and consumption. This oxygen is used principally for general plant service, hot scarfing, welding, etc.

One of the oxygen generators is equipped with an attachment to produce high purity nitrogen gas which is used as protective atmosphere for annealing coils.

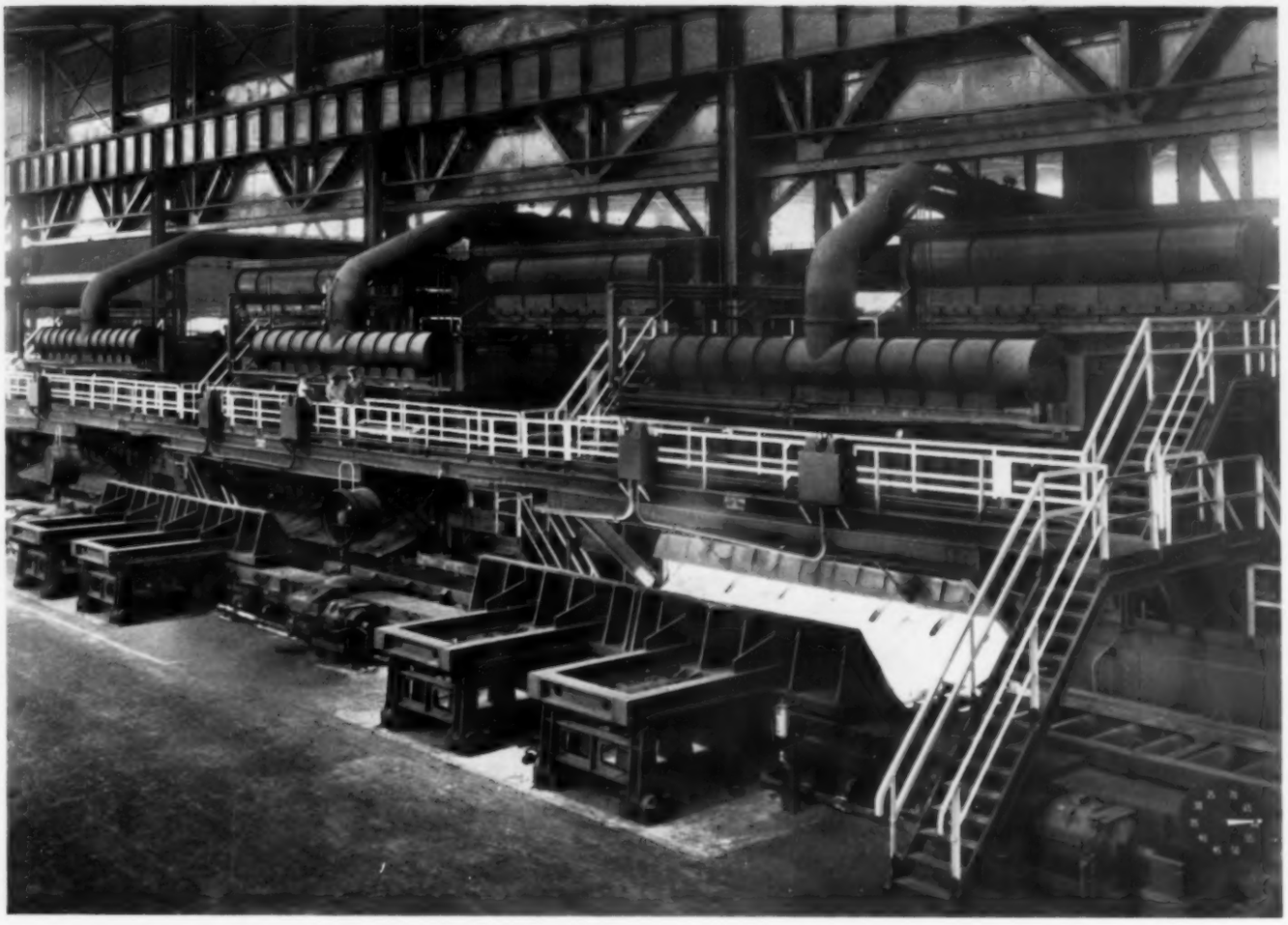
The general office at Sparrows Point, air-conditioned and modern in every respect, was completed in 1941.



BETHLEHEM STEEL COMPANY

GENERAL OFFICES: BETHLEHEM, PA.

BETHLEHEM STEEL



Three triple fired slab heating furnaces 90 ft effective heating length, inside width 24 ft 6 in. designed and built by Rust Furnace Company for East Coast strip mill.

RUST *ZONE-CONTROLLED* CONTINUOUS FURNACES

for reheating blooms, slabs, billets, bars . . .

ONLY ONE TYPE of continuous furnace provides perfect control of the heating operation from start to finish. That's the Rust Zone-Controlled Recuperative Continuous Furnace with independently fired heating and soaking chambers. Built in tandem, they assure control of tonnage output, heating quality and 100% accuracy in control of predetermined heating temperatures.

Roof design at charging end of heating chamber allows for expansion, thus reduces velocity and eliminates bleeding of waste gases. Flexibility of output is achieved by changing rate of fuel fired. Soaking chamber heat remains constant for any specific rolling temperature, gives uniform heat distribution with a minimum of fuel. Consult a Rust expert now on Double and Triple-Fired type furnaces for heating light and heavy sections.

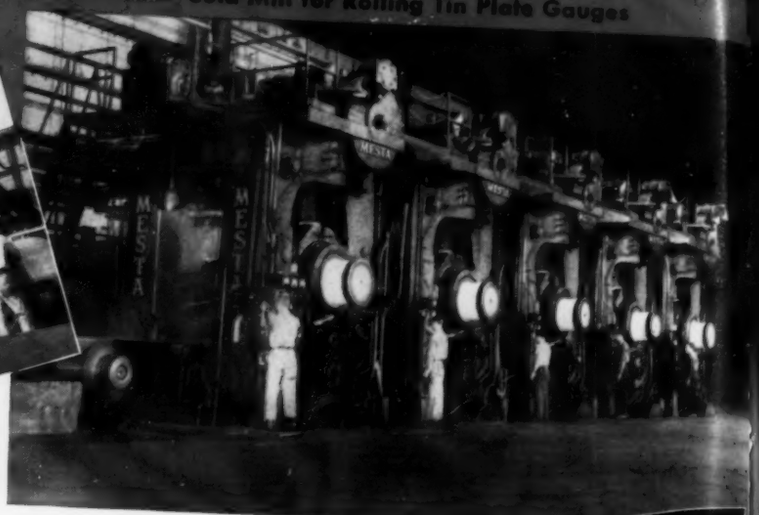
RUST FURNACE CO.
PIONEERS IN FURNACE DESIGN
PITTSBURGH, PENNSYLVANIA

THE WHOLE JOB
IS ONE JOB WITH A
RUST "PACKAGE" CONTRACT

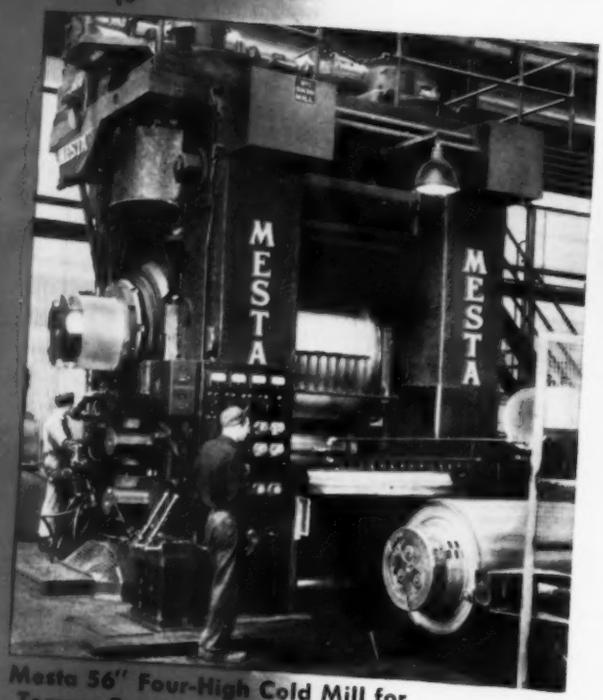
One Rust contract covers everything . . . from blueprint to test-run. Rust assumes responsibility for design, manufacture and erection of all essential material . . . including not only excavations, foundations and wiring, but all work connected with tables, pushers, controls and other equipment. Your purchasing and engineering departments are freed of subcontractor headaches when you order from Rust.

Mesta 56" Four-Stand Tandem Cold Mill
for Thin Sheet Strip and Galvanizing Stock

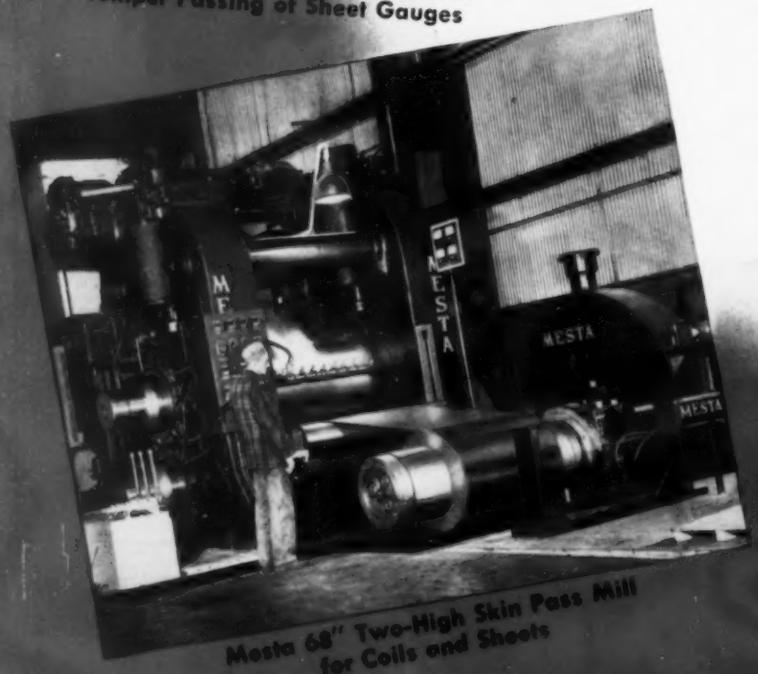
Mesta 42" Five-Stand Tandem, High Speed
Cold Mill for Rolling Tin Plate Gauges



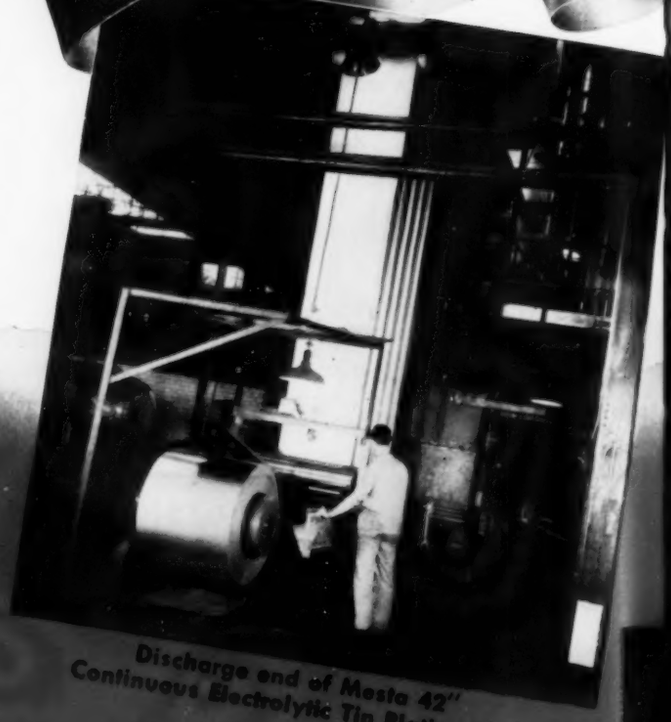
Designed and Built by MESTA



Mesta 56" Four-High Cold Mill for
Temper Passing of Sheet Gauges



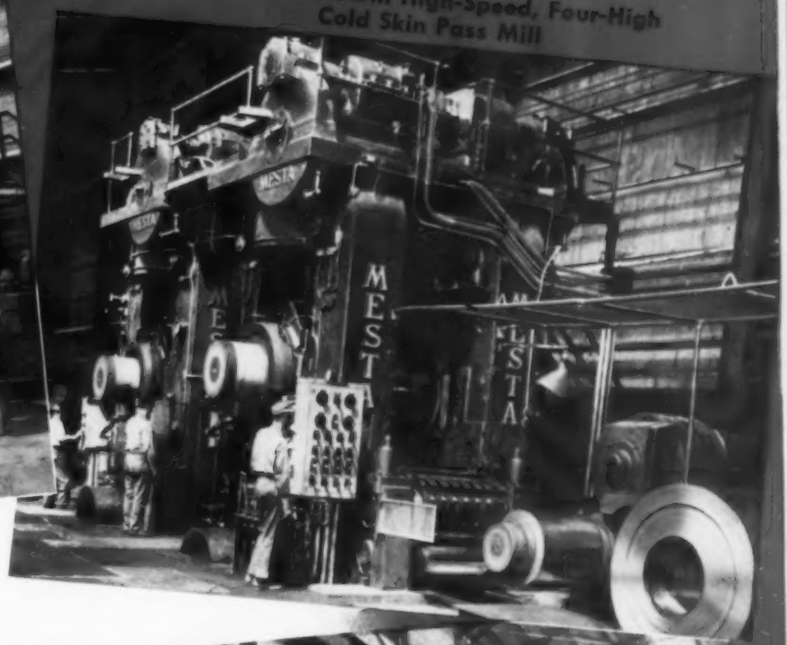
Mesta 68" Two-High Skin Pass Mill
for Coils and Sheets



Discharge end of Mesta 42"
Continuous Electrolytic Tin Plating Line

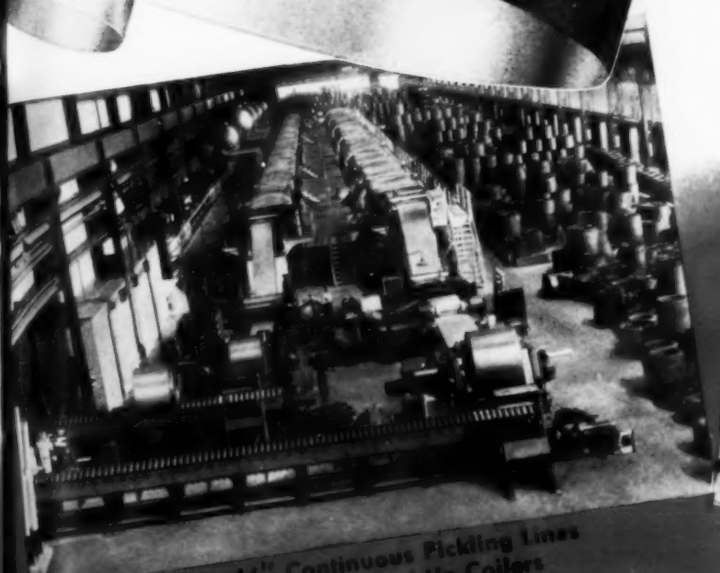
Mesta 68" Four-High Continuous Hot Strip Mill Finishing Stands

Mesta 42" Twin High-Speed, Four-High Cold Skin Pass Mill



for a large
eastern steel company

Mesta 68" Four-High Continuous Hot Strip Mill, Universal Stand



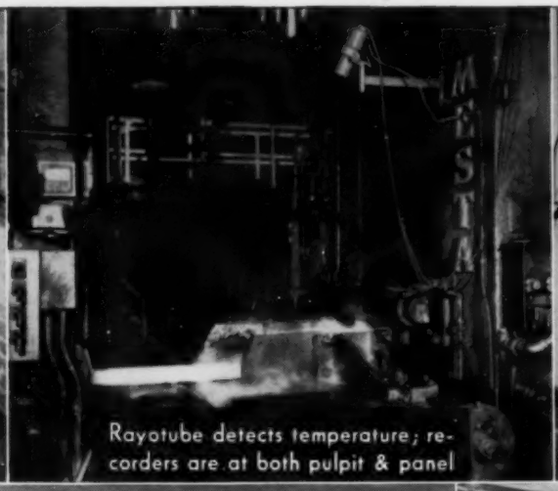
Mesta 66" Continuous Pickling Lines with Trimmers and Up-Coilers

Mesta Heavy Duty Traveling Wheel Type Roll Grinder

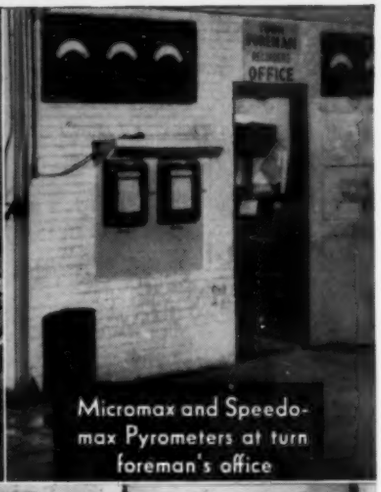
DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY • PITTSBURGH, PA.

Hot Blast Control Unit located at valves remote from Recorder



Rayotube detects temperature; recorders are at both pulpit & panel



Micromax and Speedomax Pyrometers at turn foreman's office

Hydrogen in anneal furnace atmosphere dependably recorded by Micromax instruments

Pulpit has Speedomax Recorder for strip temperature

FROM *ORE*, TO *STRIP*, TO *ANNEAL*

L&N HELPS INCREASE STEEL PRODUCTION

"Production and more production is our need. How can instruments help increase our output?"

Steel mill engineers who are asking that question of course already use hundreds of instruments to help production. A very few of these applications, old and new, are shown above.

One of the newer developments is *multiple* recording of temperatures of sheet, strip, etc. A *single* Rayotube detects the temperature of the moving steel; it is connected to *two* Speedomax Recorders — one in the pulpit, the other at the instrument panel. Thus both the roller and the turn foreman are equally and simultaneously informed of this production-influencing temperature.

Another recent innovation uses Micromax Recorders to show the percent hydrogen in the manufactured protective atmospheres of annealing cover furnaces. These Recorders help substantially to anneal at maximum speed.

Complete, integrated Temperature-Pressure-Combustion Control for all the larger furnaces minimizes or prevents time-wasting temperature swings, gives control of scaling, and enables any scheduled changes in temperature to be made in minimum time. By assuring correctness in both temperature and furnace atmosphere, it speeds production.

All L&N equipment ranks high in what some mill men call "percent availability." It stays in service, dependably; all the way from blast furnace to finishing mills. We will be glad to give details — either by catalog or in person, as you prefer. Write Leeds & Northrup Co., 4942 Stenton Ave., Philadelphia 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

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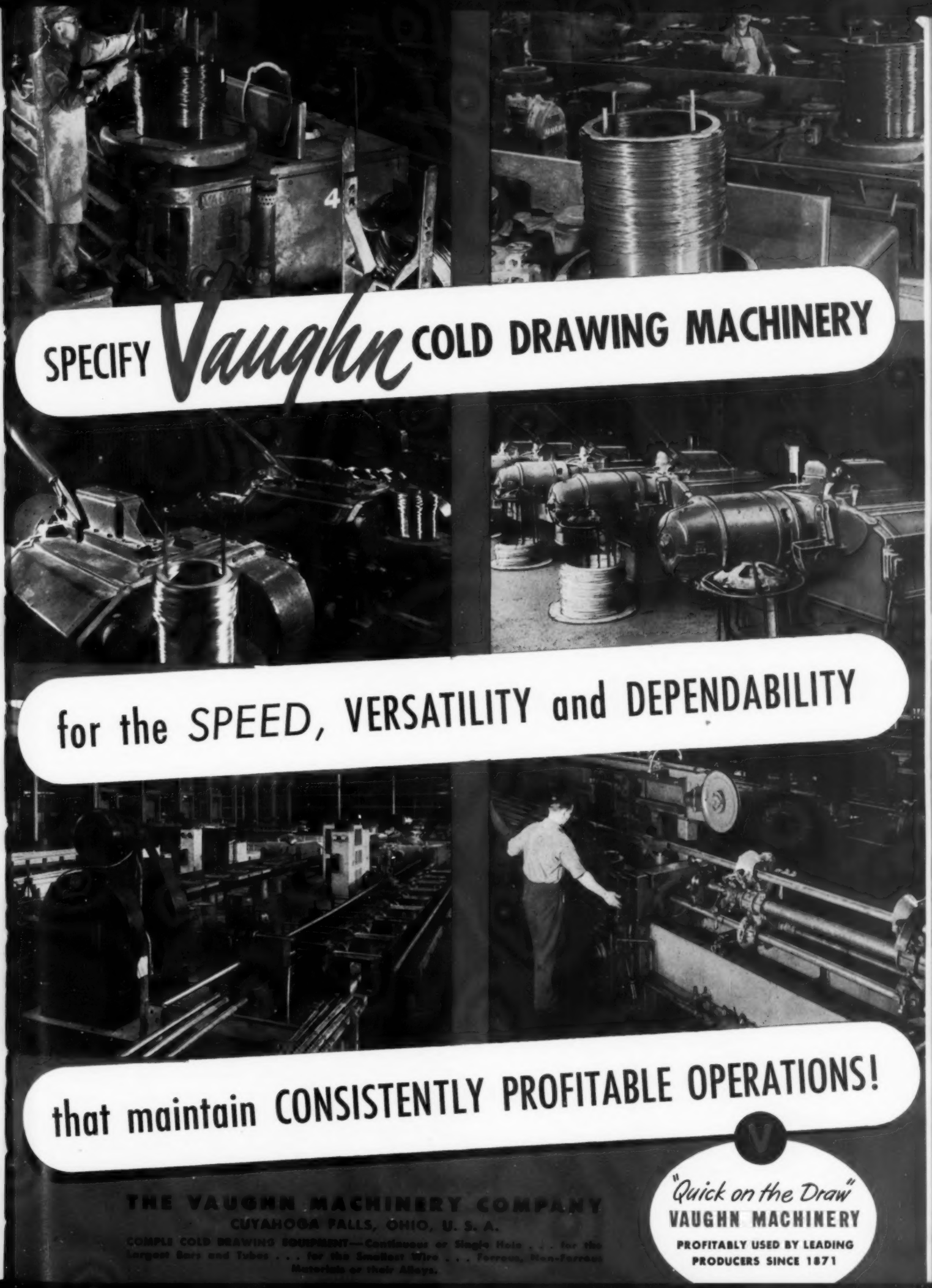
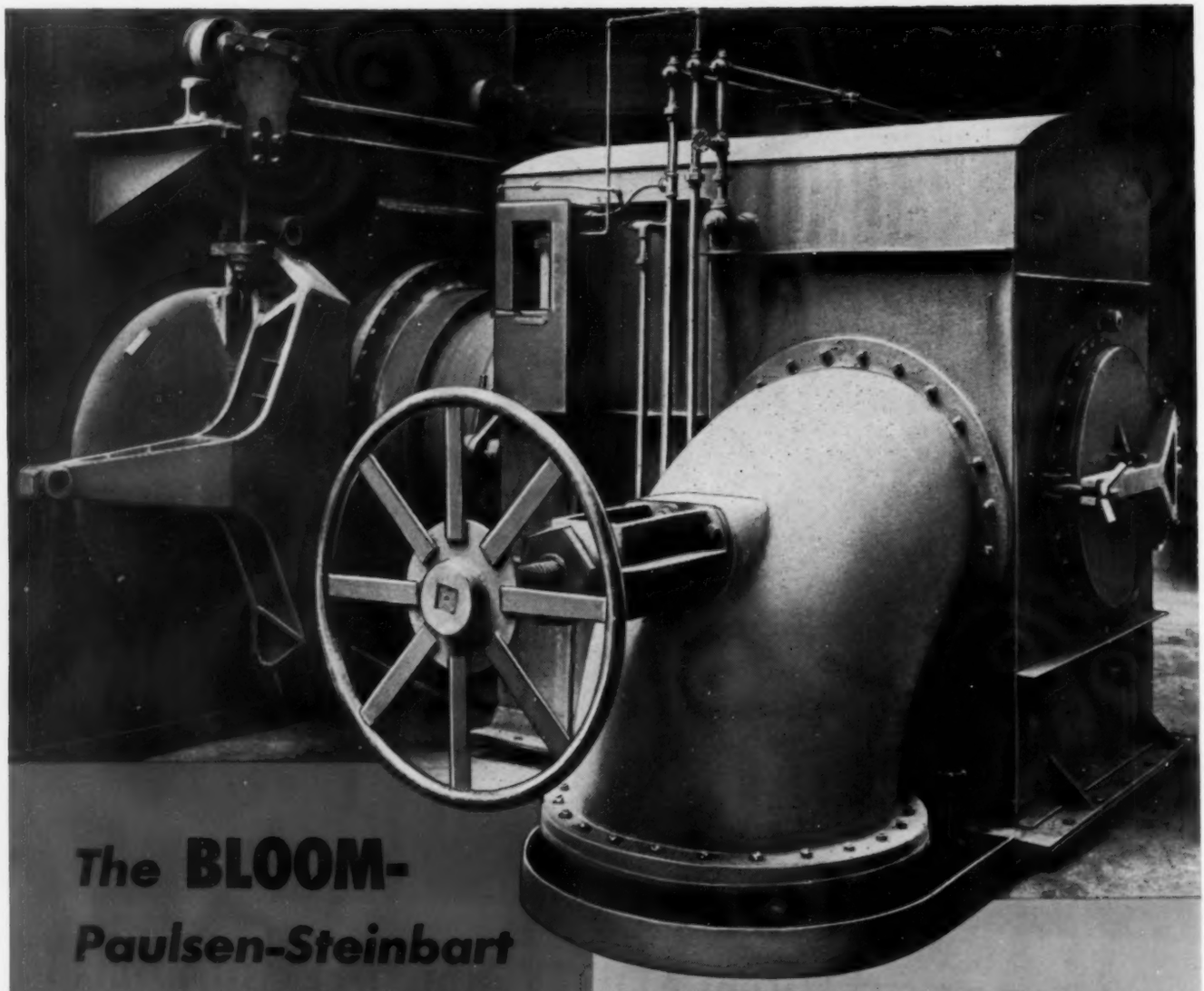

SPECIFY Vaughn COLD DRAWING MACHINERY
for the SPEED, VERSATILITY and DEPENDABILITY
that maintain CONSISTENTLY PROFITABLE OPERATIONS!
THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO, U. S. A.
COMPLE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.
"Quick on the Draw"
VAUGHN MACHINERY
PROFITABLY USED BY LEADING PRODUCERS SINCE 1871

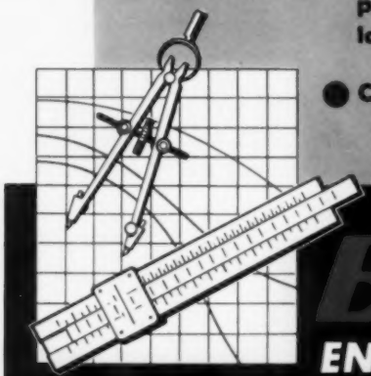


The BLOOM-
Paulsen-Steinbart

BLAST FURNACE
STOVE BURNER

- Provides proper combustion condition to develop correct temperature distribution for maximum stove heating capacity.
- Patented arrangement of air distribution vanes make possible the construction of a compact burner unit.
- Correct measurement of air and gas flows is provided by an unusual burner construction. Thus any good ratio regulator will provide proper control of air flow in relation to gas flow.
- Compact, flexible and easy to operate.

WRITE for new bulletin describing the BLOOM-Paulsen-Steinbart Blast Furnace Stove Burner.

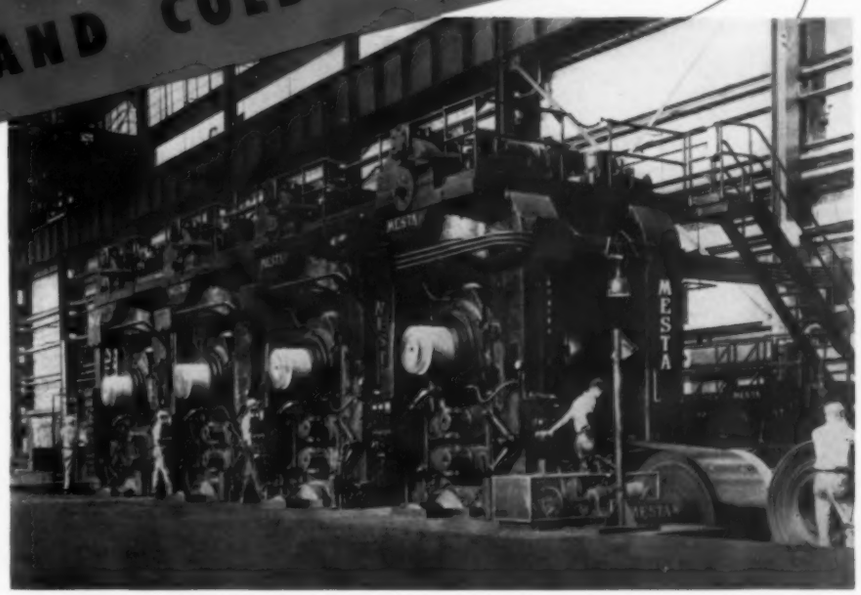


BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 12, Pa.

Finishing train of 68″ hot strip mill.

56″ cold mill.

NEW HOT AND COLD MILLS ARE



EQUIPPED WITH TIMKEN® BEARINGS

The new 68″ hot strip mill and 56″ cold mill installed in a large eastern steel plant are equipped with Timken roll neck bearings on all work rolls.

In addition, Timken roller thrust bearings are used to carry the heavy thrust loads developed by the back-up bearings.

The cold mill drives also are equipped with Timken bearings, as are the hot and cold mill tables, table drives and some of the reels.

Since Timken bearings were first applied to mill roll necks nearly 25 years ago, they have rolled millions of tons of steel with consistent accuracy and low bearing cost per ton rolled.

Today, Timken Balanced Proportion Bearings show load ratings up to 40% higher than previous designs of tapered roller bearings, size for size. They also make possible 50% to 60% increase in neck strength, thereby assuring greater mill and bearing rigidity and resulting in higher rolling precision. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address "TIMROSCO".

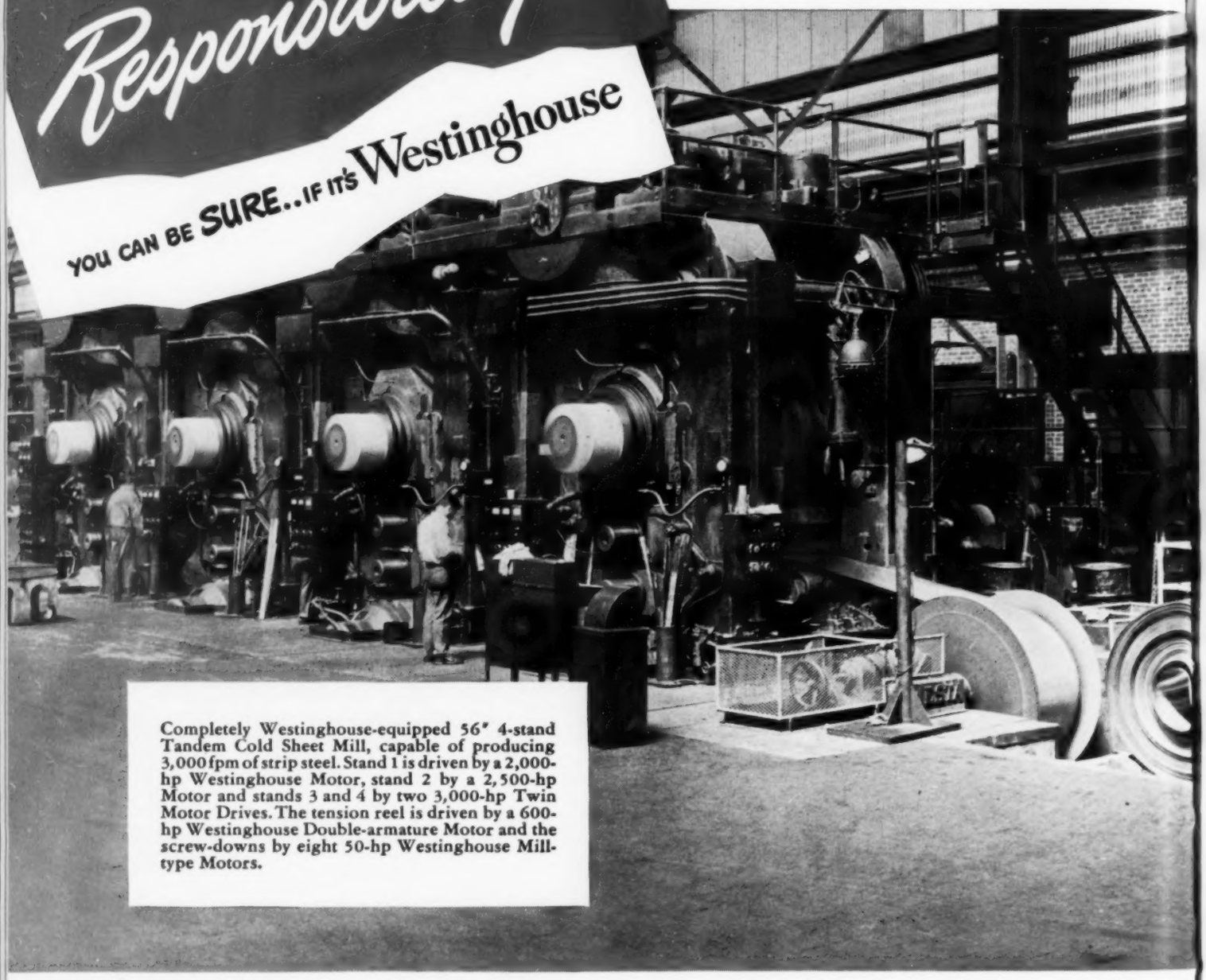
TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION →◫←

Unit Responsibility

KEY TO MORE

YOU CAN BE SURE... IF IT'S Westinghouse



Completely Westinghouse-equipped 56" 4-stand Tandem Cold Sheet Mill, capable of producing 3,000 fpm of strip steel. Stand 1 is driven by a 2,000-hp Westinghouse Motor, stand 2 by a 2,500-hp Motor and stands 3 and 4 by two 3,000-hp Twin Motor Drives. The tension reel is driven by a 600-hp Westinghouse Double-armature Motor and the screw-downs by eight 50-hp Westinghouse Mill-type Motors.

FROM PLANNING BOARD TO PRODUCTION...
YOUR BEST ANSWER TO ALL OF YOUR ELECTRICAL AND POWER PROBLEMS

The high production rate of today's steel mills is a story of continuous development in methods and machines. The trend is toward a higher degree of electrification very necessary for flexible power and accurate control.

In this development program, Westinghouse has been responsible for an impressive list of important contributions to the steel industry, worked out in co-operation with steel mill engineers.

For this reason, Westinghouse today is regarded as an operating partner of the steel industry, offering engineering "know-how" and a single source for apparatus—for every electrical or power problem. The result is the highest degree of co-ordinated electrification.

For help in working out your problems—for the best in drive, control and lighting equipment—call on Westinghouse. It's your soundest assurance of maximum performance and dependability. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-94769

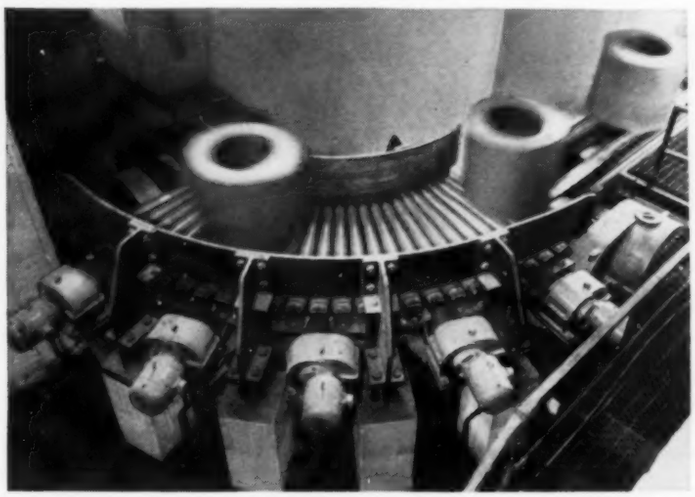
PRODUCTIVE POWER

"WESTINGHOUSE-EQUIPPED THROUGHOUT" MEANS SIMPLIFIED ORDERING, QUICKER INSTALLATION, MORE EFFICIENT OPERATION

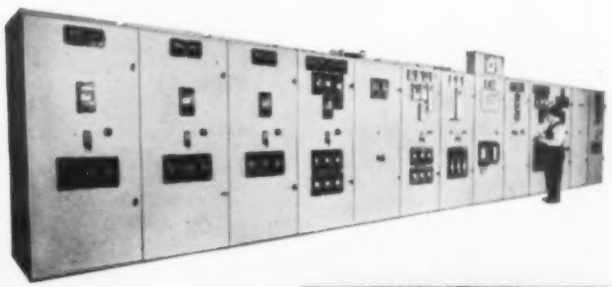
Putting power to work *productively* can be a major problem . . . or a simple one. When items must be selected, ordered and received from many sources, it means many chances for costly errors and delays . . . divided responsibility for performance of installed equipment.

Westinghouse offers the way to simplify the job. From equipment for generation of electrical or steam power, to the most specialized types of drives, gearing and control for its utilization, Westinghouse provides a single source of supply . . . competent to take responsibility for performance of all parts of the job.

A typical example of Westinghouse unit responsibility is the installation of a 56″ Tandem Cold Mill—illustrated on these pages. This is one of today's most modern mills. It is completely Westinghouse-equipped, and is Rototrol-regulated for fully automatic control of speed and tension.



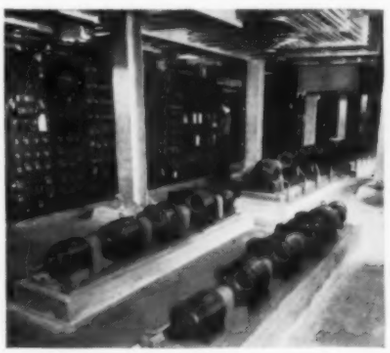
COIL CONVEYOR system between hot mills and tandem cold mill. The tapered rolls comprising the 90° bend are synchronized with the conveyors by use of variable frequency drives. Eleven 35-hp Westinghouse Mill Motors drive about 1,000 feet of conveyor. Five 1-hp Westinghouse Gearmotors drive the 90° bend.



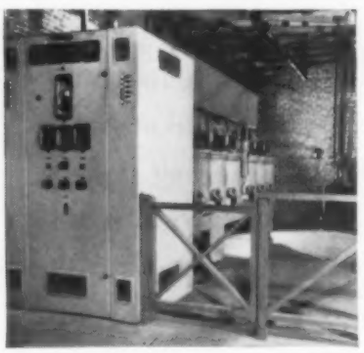
SWITCHGEAR — 6,600-volt Westinghouse Metal-clad Switchgear for entire cold mill. Includes high-voltage, a-c circuits for tandem mill, skin-pass mill and 7 Power Centers.

AIR CLEANING—108,000 cfm Westinghouse Precipitron, for cleaning the air from the 8,000-kw synchronous m-g set, prior to recirculating the air into the motor room.

MOTOR ROOM of tandem sheet mill. On the left are Westinghouse Main Roll Drive Motors. In the background is an 8,000-kw Westinghouse M-G Set. Exciters, Rototrols and I-R Drop Compensator are in the right foreground.



CONTROL panels, exciters and Rototrols for two single-stand, skin-pass mills. Here complex control problem is simplified by systematic location of many conduits.



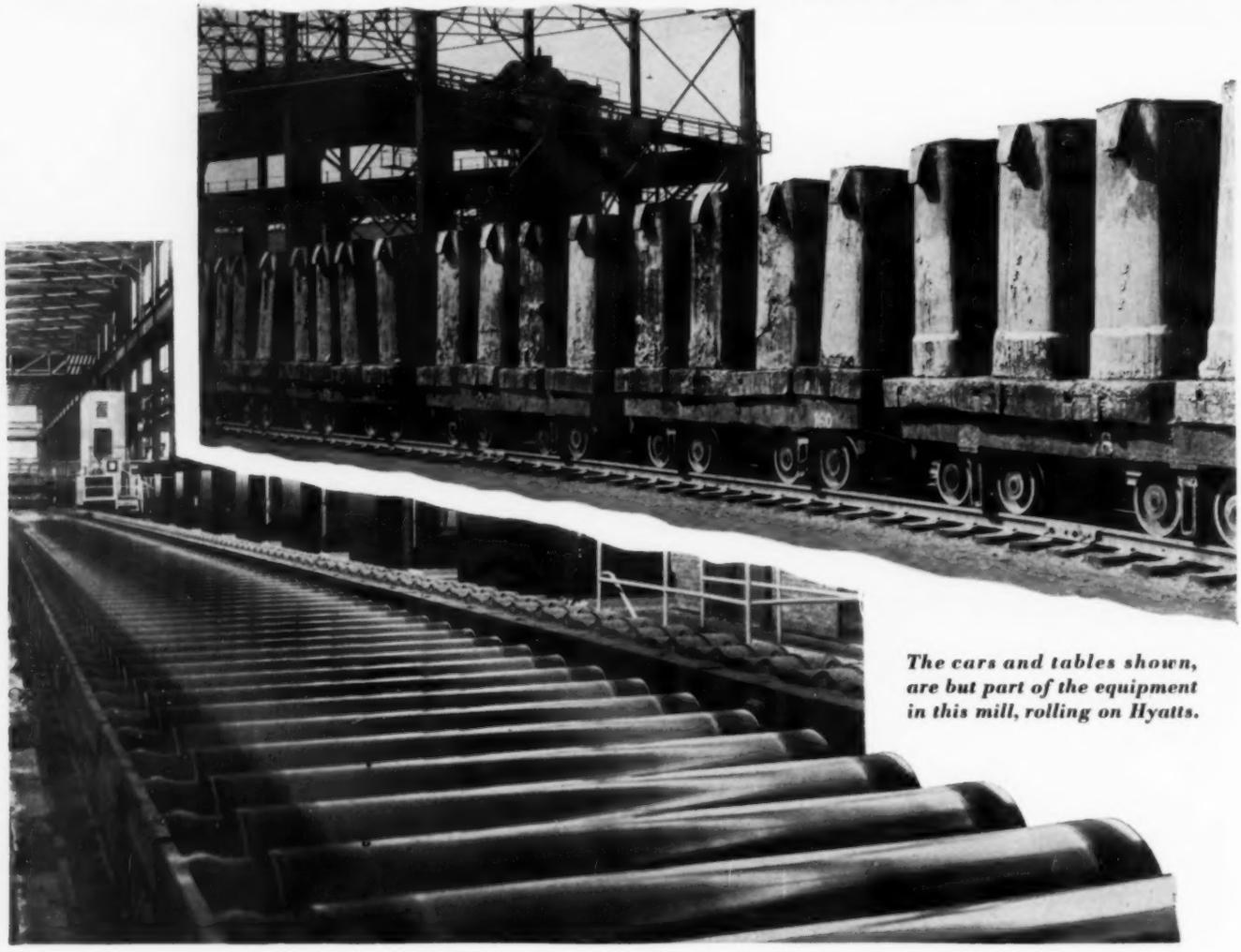
RECTIFICATION — This 1,000-kw Westinghouse Ignitron Rectifier provides d-c power for auxiliaries requiring constant voltage.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

MORE PRODUCTIVE POWER FOR INDUSTRY

HYATTS...OF COURSE



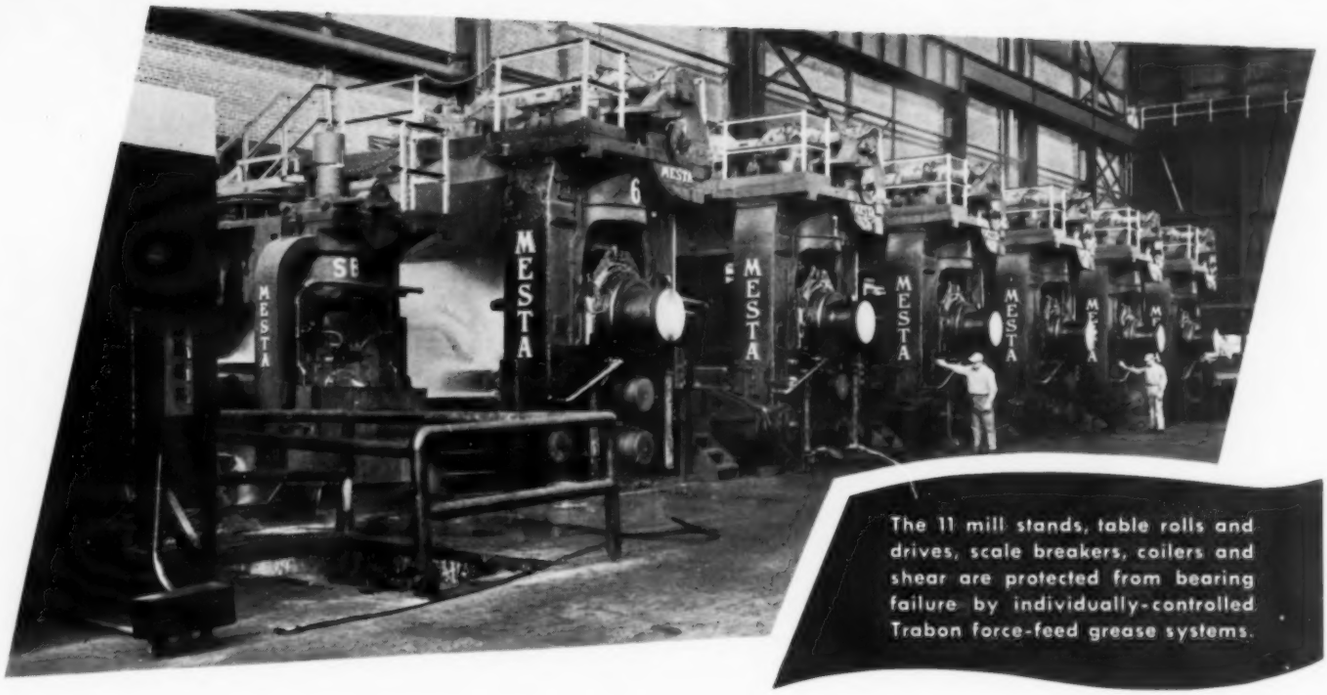
The cars and tables shown, are but part of the equipment in this mill, rolling on Hyatts.

IN the largest steel mill in the east, employing the most modern methods and equipment for economical and speedy production—you will find Hyatt Roller Bearings, of course, on the job.

Having served so well for so many years Hyatts have earned their reputation as the preferred roller bearings for steel mills.

On new equipment always specify Hyatts and on change-over jobs use Hyatts to be sure of outstanding production performance. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS



The 11 mill stands, table rolls and drives, scale breakers, coilers and shear are protected from bearing failure by individually-controlled Trabon force-feed grease systems.

New Hot Strip Mill Equipped with *Trabon* Lubricating Systems

WHY MASTER MECHANICS PREFER *Trabon*

- ✓ *Trabon* is Positive
- ✓ *Trabon* is Sealed
- ✓ *Trabon* is Hydraulic
- ✓ *Trabon* has the Single Indicator

The new 68-inch hot strip mill of a large eastern steel producer is completely equipped with Trabon Lubricating Systems. Each of the 11 mill stands and each table, coiler, scale-breaker and shear has its own system. All mill stand systems are automatically-operated. Other systems are manually-operated.

The completely sealed Trabon System may be buried under scale, dirt and grime. For the single indicating point at the pump tells the whole story—giving positive proof when the cycle is completed—giving warning when a blocked line occurs *before the bearing is lost from lack of lubrication.*

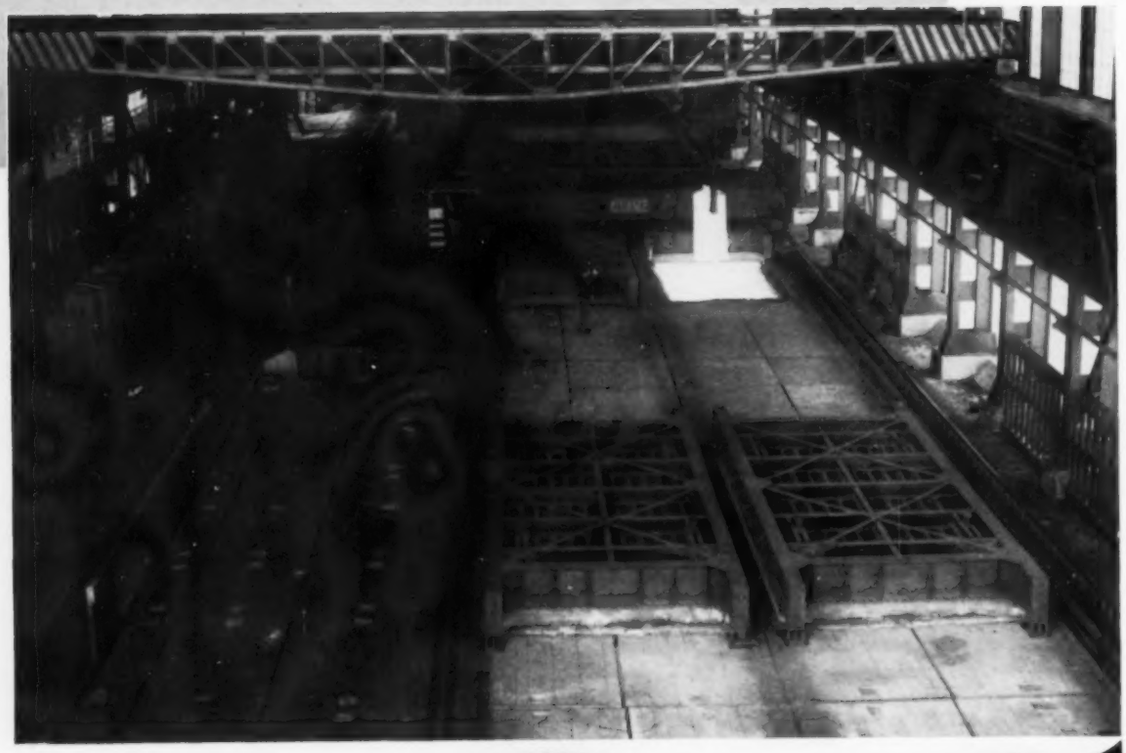
Then, too, Trabon's single line system is easy to install. Small automatic pumping units, in addition to large floor-mounted units, make it economical to sectionalize your lubricating system, ordering and installing small units at a time. Write or 'phone your Trabon representative today. He'll be glad to help you solve your lubricating problems.

Trabon ENGINEERING CORPORATION

1814 EAST 40TH STREET • CLEVELAND 3, OHIO

Centralized Oil and Grease Systems

FOR IMPROVED INGOT HEATING



F.E.I. SOAKING PITS

The new style regenerative soaking pits designed by Furnace Engineers, Inc., will increase your output of heated ingots and substantially lower your fuel and maintenance costs. Fired by a mixture of cold and clean blast furnace gas enriched with coke oven gas, the soaking pits provide higher temperatures in the preheated air.

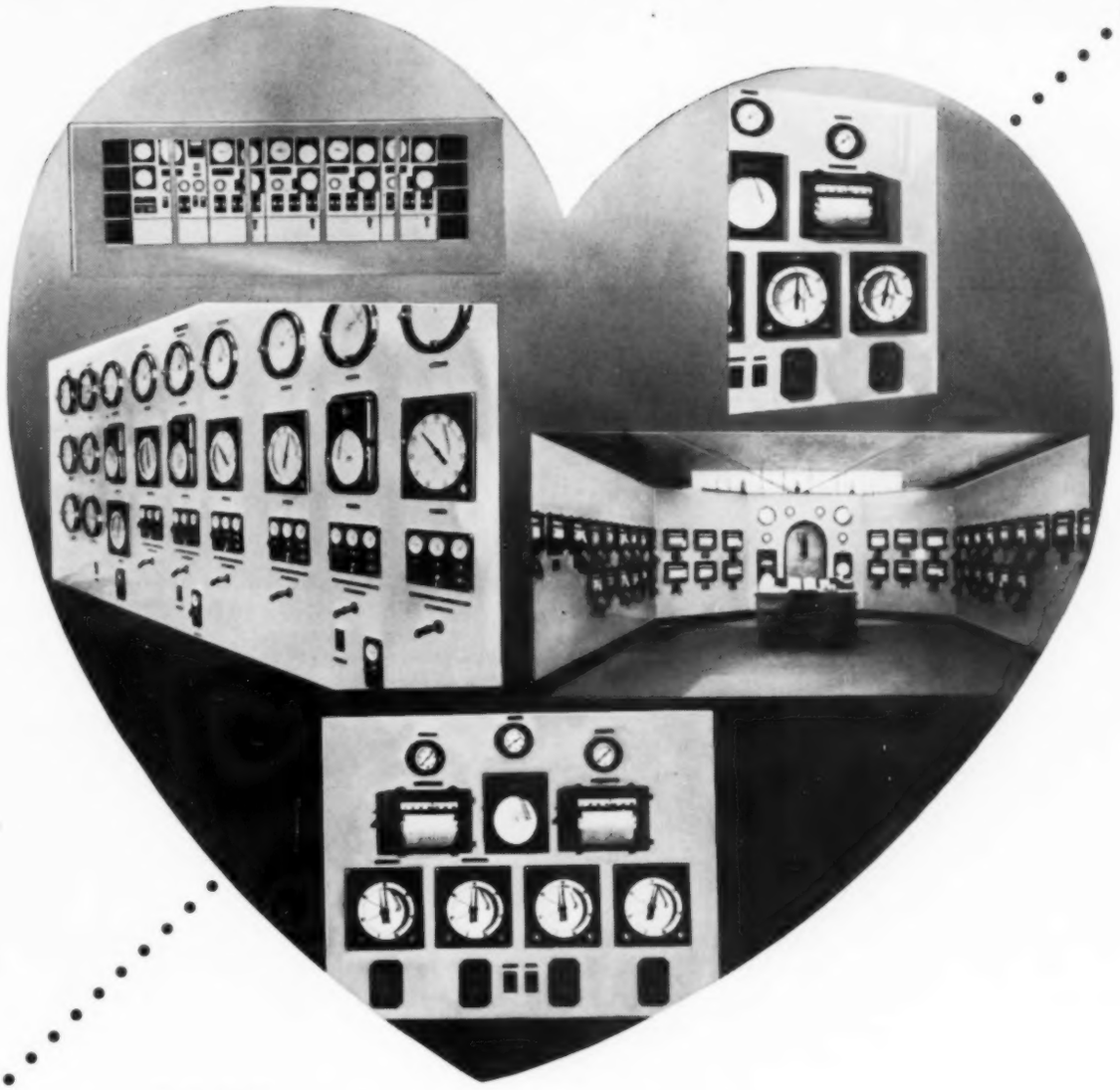
F.E.I.'s new regenerative soaking pits include all the latest improvements: most modern instrumentation, double-pass checkers, Isley controls, flat door arches and flat checker arches. They operate with the utmost efficiency and dependability.

An F.E.I. representative will be glad to provide you with full details at your convenience. Write or call today.

U. S. PATENTS—2,446,642; 2,403,431; 1,913,170.
OTHER PATENTS PENDING.

FURNACE ENGINEERS, INC.
1552 W. Liberty Ave., Pittsburgh, Pa.

The Heart of a Steel Plant



Nearly 2000 Brown Recording and Controlling Instruments In One Large Steel Producing Plant

Just *one plant* of this very large producer uses nearly 2,000 Brown instruments . . . *Electroni K* Potentiometers, Pressure Gauges, Flow Meters with pneumatic or electric control. They're found in every important operation . . . Coke Oven, Blast Furnace, Open Hearth, Soaking Pit, Re-Heating Furnace . . . Pickling, Annealing, Normalizing, Tinning, Galvanizing.

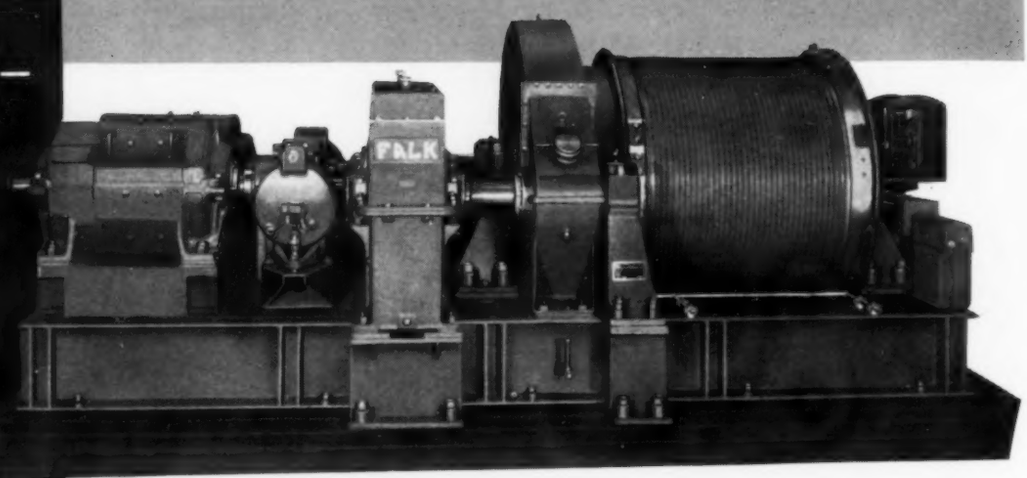
These Brown instruments work together as a great team . . . coordinating operations and processes . . . providing precision control and flexibility for this industrial giant.

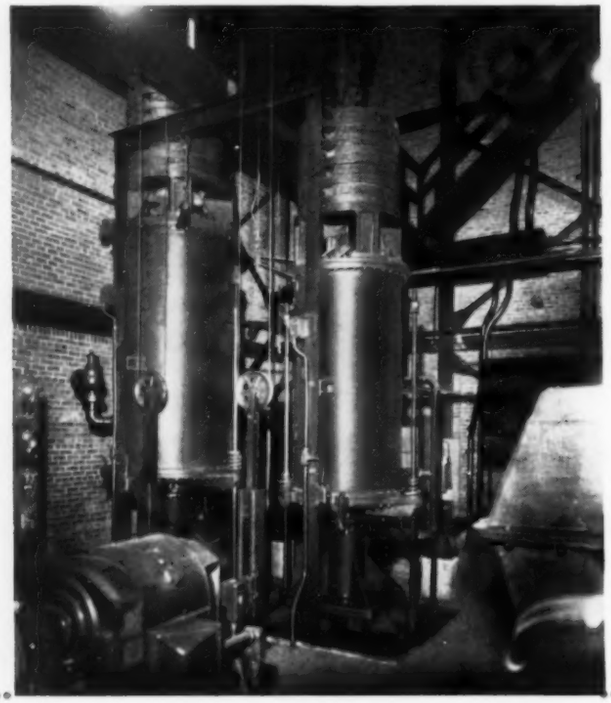
MINNEAPOLIS-HONEYWELL REGULATOR CO.
BROWN INSTRUMENTS DIVISION
4464 Wayne Ave., Philadelphia 44, Pa.
Offices in principal cities of the United States, Canada and throughout the world

MINNEAPOLIS Honeywell — *Advanced Instrumentation* FOR METAL PRODUCING — BROWN INSTRUMENTS

For Blast Furnaces of Distinction

FREYN-DESIGN SKIP HOISTS





and..

FREYN-DESIGN BELL HOISTS

THESE EQUIPMENTS, OF DEMONSTRATED MERIT, ARE SERVING AMERICA'S MOST MODERN BLAST FURNACES

Freyn Engineering Company

CONSTRUCTORS — ENGINEERS — SPECIALTIES

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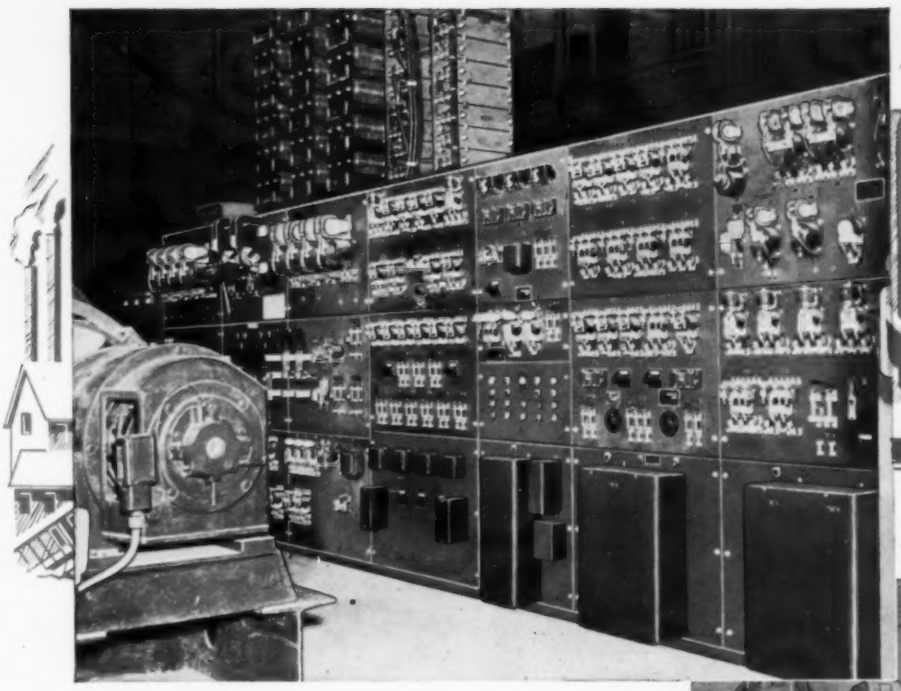
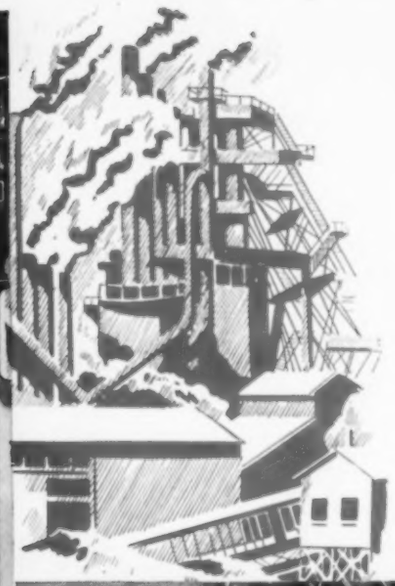
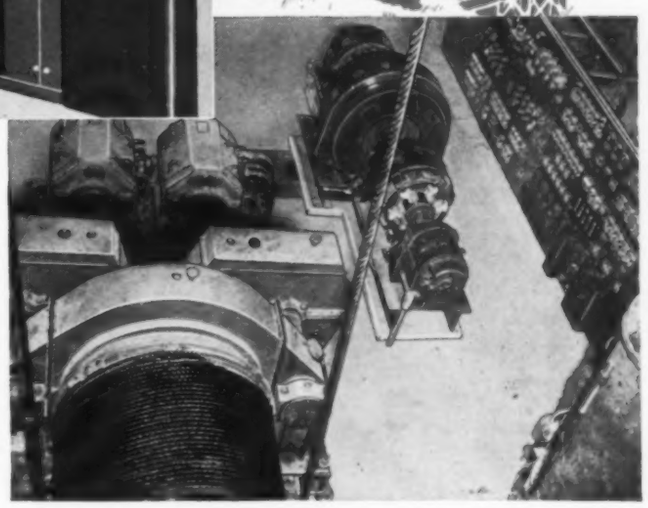






CLARK-BUILT... FREYN-DESIGN

BLAST FURNACE SKIP HOIST AND CHARGING CONTROL

Adjustable Voltage control is employed on this Skip Hoist, installed in a large Eastern steel plant.

This Skip Hoist is driven by two 200 H.P., 230 V., D.C. Mill Type Motors. Power is supplied from two 200 K.W. Generators.

The control provides the following combinations:

a. Dual drive hoist motors supplied by their respective generators or by both generators in parallel.

b. Single operation of either motor supplied by paralleled generators.

c. Single generator operation supplying both hoist motors in series.

Any of the above combinations can be selected by means of main circuit and auxiliary circuit transfer switches on the hoist panel. These combinations are responsive either to full automatic charging control or to manual master switch operation.

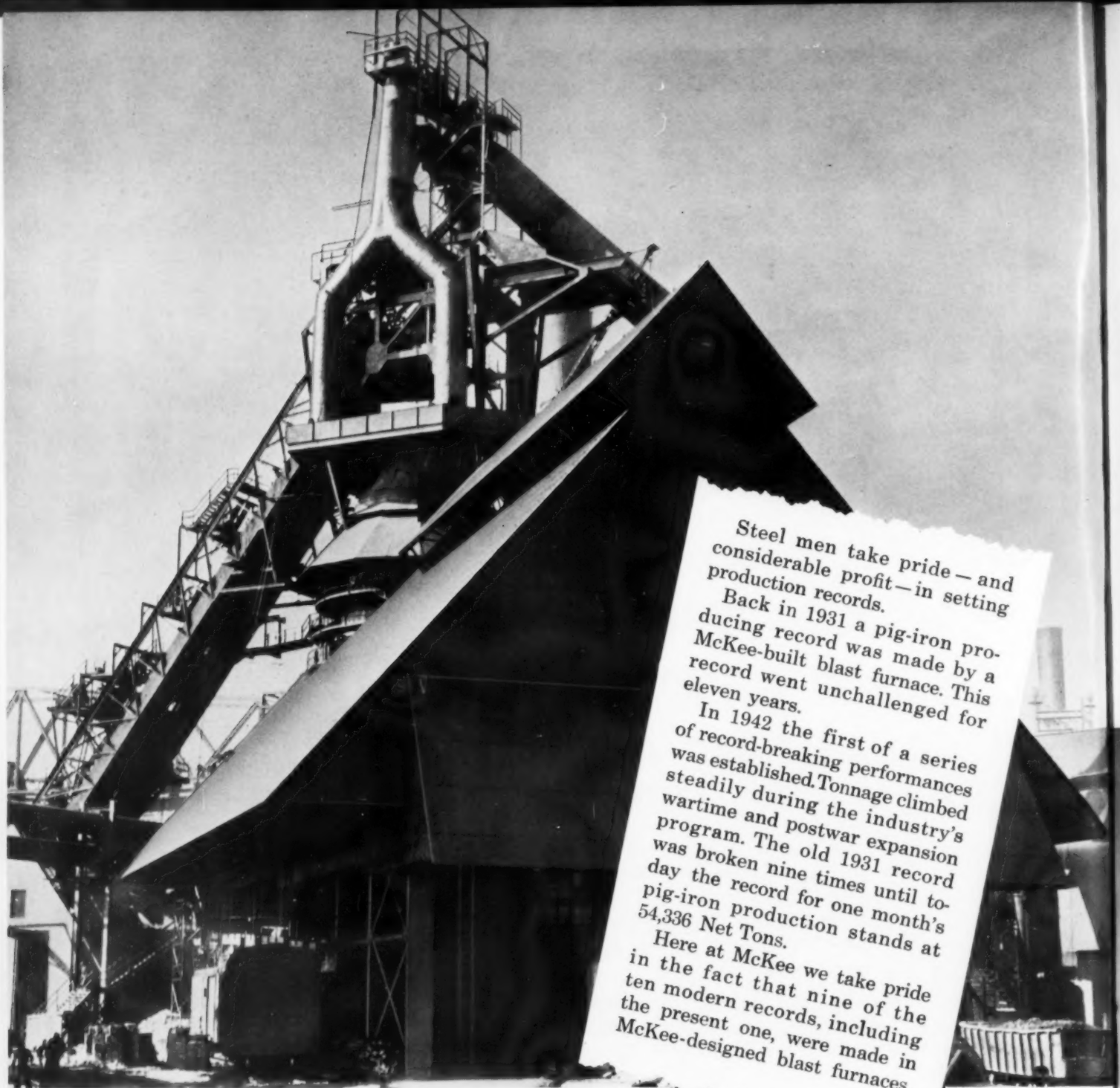
The Charging Control panels provide control for 16 motors which govern the handling of 4800 net tons of material into the Blast Furnace each 24 hour day.

The handling of these materials is controlled from the time they leave the scale car, or the central coke bins, until they reach the burden inside the Blast Furnace. The different operations are performed automatically, and are controlled so that they can be performed only in the proper sequence.

FREYN ENGINEERING plus CLARK CONTROL EQUIPMENT are successfully operating on installations all over the world.

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO



Steel men take pride — and considerable profit — in setting production records.

Back in 1931 a pig-iron producing record was made by a McKee-built blast furnace. This record went unchallenged for eleven years.

In 1942 the first of a series of record-breaking performances was established. Tonnage climbed steadily during the industry's wartime and postwar expansion program. The old 1931 record was broken nine times until today the record for one month's pig-iron production stands at 54,336 Net Tons.

Here at McKee we take pride in the fact that nine of the ten modern records, including the present one, were made in McKee-designed blast furnaces.

Another WORLD'S RECORD

54,336 NET TONS
1752.7 AVERAGE PER DAY

Record breaking performance can be expected when sound top management provides efficient operating personnel with good raw materials *and a McKee-designed blast furnace.*

ARTHUR G. McKEE & COMPANY

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE IRON AND STEEL AND PETROLEUM REFINING INDUSTRIES

ENGINEERS AND CONTRACTORS • ESTABLISHED 1905
2300 CHESTER AVENUE, CLEVELAND
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The Iron & Steel Division of Arthur G. McKee & Company is represented in England by the McKee Iron & Steel Division of HEAD, WRIGHTSON & CO., LTD.

ANNUAL SPRING CONFERENCE PROGRAM

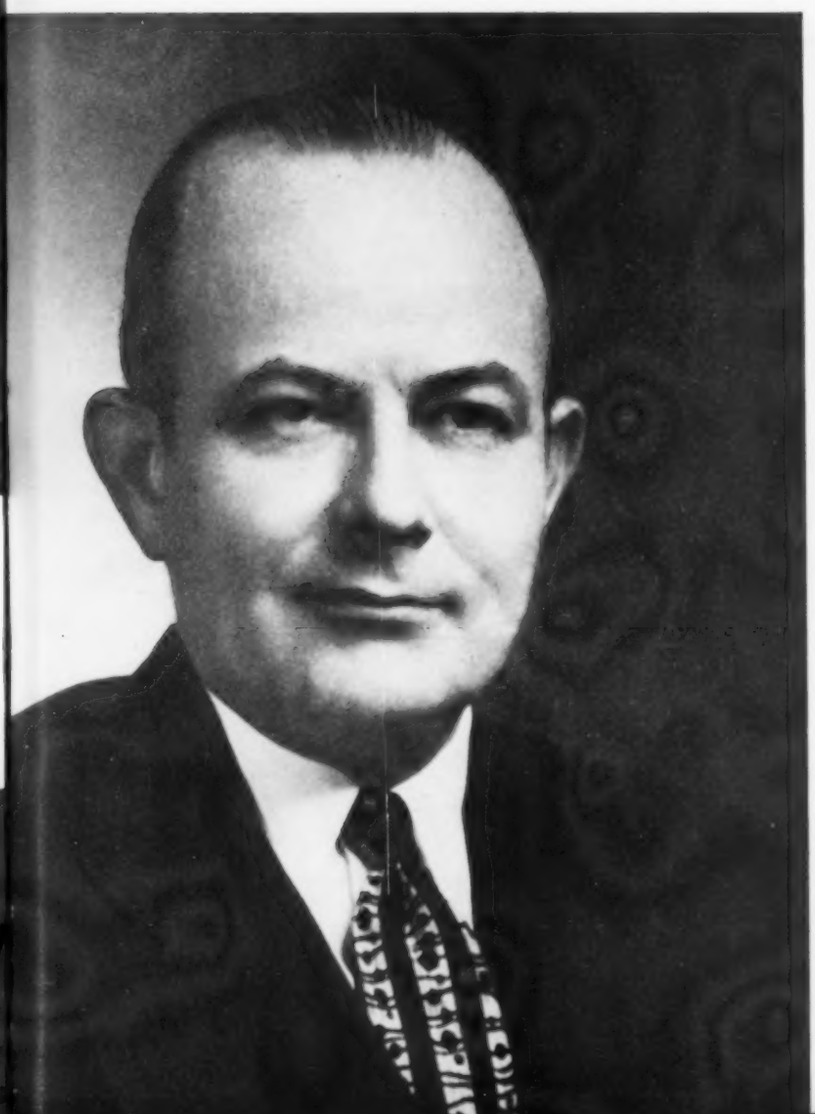
Sponsored by the Rolling Mill Committee of

ASSOCIATION OF IRON AND STEEL ENGINEERS

LORD BALTIMORE HOTEL

BALTIMORE, MARYLAND

MAY 2 and 3, 1949



An Invitation . . .

. . . is extended to all steel mill operators and engineers to participate in the Annual Spring Conference of the Association of Iron and Steel Engineers. This meeting features papers designed to continue the advancement of the technical and engineering phases of steel mill operation. With our mills working to the limit, we need to garner every possible bit of information to help keep production up and costs down.

This meeting offers just such an opportunity and we hope that you will be able to attend.

C. H. WILLIAMS
President AISE

WILLIAM HERMAN

EDWARD T. PETERSON

LEWIS W. KING

EDWARD C. PETERSON

Annual Spring Conference Program

MONDAY, MAY 2, 1949

9:00 a.m. — Registration — Second Floor Foyer, Lord Baltimore Hotel

9:15 a.m. — Technical Meeting — Calvert Room

Co-Chairmen:
James N. Imel
Superintendent of Rolling Mills
Jones and Laughlin Steel Corp.
Pittsburgh, Pa.

R. E. Beynon
Superintendent Roll Shop
Carnegie-Illinois Steel Corp.
Chicago, Ill.

"Blooming Mill Operations at Keystone Steel and Wire Co."
William Herman, Superintendent of Rolling Mills
Keystone Steel and Wire Co.
Peoria, Ill.

"New Rod Mill for Rolling Stainless Steels at Rustless"
Edward T. Peterson, Lewis W. King and Edward C. Peterson
Birdsboro Steel Foundry and Machine Co.
Birdsboro, Pa.

"Electrical Equipment for a Modern Rod Mill"
F. R. Burt and R. W. Moore, Metal Working Section
Westinghouse Electric Corp.
East Pittsburgh, Pa.

9:15 a.m. — Technical Meeting — Founder's Room

Co-Chairmen:
A. D. Howry
Assistant Superintendent
Maintenance in Charge of Electrical Dept.
Alan Wood Steel Co.
Conshohocken, Pa.

H. H. Angel
Electrical Engineer
Engineering and Construction Dept.
Bethlehem Steel Co.
Bethlehem, Pa.

"Electric Equipment for High Speed 2-Stand Temper Mills"
Roscoe E. Marrs, Application Engineer
Steel Mill Division, General Electric Co.
Schenectady, N. Y.

"Power Supply and Electrical Features of a 68 in. Hot Strip Mill"
F. O. Schnure, Electrical Superintendent
Bethlehem Steel Co.
Sparrows Point, Md.

"Main Drive Motors for a 68 in. Hot Strip Mill"
H. W. Bartling, Steel Mill Section
Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

1:00 p.m. — Buses leave Lord Baltimore Hotel for Inspection Trip through plant of Rustless Iron and Steel Division of Armco Steel Corp.

7:00 p.m. — Dinner — Calvert Room

Speaker: Stewart J. Cort, Vice President, Bethlehem Steel Co.

F. R. BURT

ROSCOE E. MARRS

F. O. SCHNURE

TUESDAY, MAY 3, 1949

9:00 a.m. — Technical Meeting — Calvert Room

Co-Chairmen:
Louis Moses
Superintendent Rail Mill and Roll Dept.
Bethlehem Steel Co.
Sparrows Point, Md.

Charles P. Hammond
Superintendent Mills
Rotary Electric Steel Co.
Detroit, Mich.

"Roll Design of Small Shapes"
William H. Mohler, Superintendent Roll Turning Department
Carnegie-Illinois Steel Corp.
McDonald, Ohio

"Budgeting Blooming Mill Maintenance"
J. Harry Mayer, Assistant Superintendent
Blooming Mills Department
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

WILLIAM H. MOHLER

9:00 a.m. — Technical Meeting — Founder's Room

Co-Chairmen:
H. S. Hall
Fuel Engineer
Lukens Steel Co.
Coatesville, Pa.

C. E. Duffy
Fuel Engineer
Bethlehem Steel Co.
Sparrows Point, Md.

"Design and Performance of Modern Large Rotary Furnaces"
Andrew F. Kritscher, Development Engineer
National Tube Co.
Pittsburgh, Pa.

"New Power for Sparrows Point"
J. M. Spencer, Assistant Fuel Engineer
Bethlehem Steel Co.
Sparrows Point, Md.

J. HARRY MAYER

ANDREW F. KRITSCHER

12:30 p.m. — Buses leave Lord Baltimore Hotel for Inspection Trip through Sparrows Point Plant of Bethlehem Steel Co.

HOTEL RESERVATIONS SHOULD BE MADE DIRECT TO THE LORD BALTIMORE HOTEL, BALTIMORE 3, MARYLAND STATING THAT THEY ARE FOR THE AISE SPRING CONFERENCE. RESERVATIONS SHOULD BE MADE AS SOON AS POSSIBLE IN ORDER TO OBTAIN REQUIRED ACCOMMODATIONS.

MONDAY, MAY 2, 1949

1:00 P. M.

Buses leave Lord Baltimore Hotel for Inspection Trip through Baltimore plant of Rustless Iron and Steel division of Armco Steel Corp.

RUSTLESS IRON AND STEEL DIVISION
ARMCO STEEL CORP.

Inspection Trips

BETHLEHEM STEEL CO.
SPARROWS POINT PLANT

TUESDAY, MAY 3, 1949

12:30 P. M.

Buses leave Lord Baltimore Hotel for Inspection Trip through Sparrows Point plant of Bethlehem Steel Co.

ABSTRACTS OF TECHNICAL PAPERS

Annual Spring Conference

May 2-3, 1949

Baltimore, Maryland

ELECTRICAL EQUIPMENT FOR A MODERN ROD MILL

By F. R. BURT
and
R. W. MOORE
Metal Working Section
Westinghouse Electric Corp.
East Pittsburgh, Pa.

▲ THERE is a definite trend toward the use of continuous mills in the production of rod. As compared with looping mills, higher speeds can be utilized, the temperature is maintained at a higher value resulting in lower power costs, less space is required and labor costs are lower. However, the continuous mill with multiple stands driven by one motor has one outstanding disadvantage—its inflexibility. Since all stands are geared together, the per cent reductions through the mill are fixed. It is of advantage only in plants producing large tonnages in a very limited range of sizes.

Flexibility of output requires that individual adjustment of the speed of each stand or of small groups of stands be possible so that the per cent reductions can be varied to suit different overall elongations. It is therefore necessary to drive each stand or group of stands by means of a direct current adjustable speed motor.

On a mill of this kind there can be no looping, and particularly where a precision product, or more than one strand is rolled, the stretching should be kept to a minimum. In other words, the speed relationship of the motors should be maintained as nearly constant as possible.

Any motor, regardless of how flat its steady state speed regulation is, drops in speed when a load is applied suddenly and then recovers to steady state speed at that load. The initial rate of deceleration is directly proportional to the load applied and inversely proportional to the mechanical inertia of the system. However, as soon as the speed and therefore the counter emf start to drop, more current flows in the armature and the motor torque increases. This lowers the rate of deceleration, the motor speed reaches a minimum value and then recovers to steady state value. The rate at which the motor torque builds up the time of recovery depends on the inductance of the armature circuit. On a motor of normal design, the impact speed drop may be three or four per cent and the time of recovery four or five seconds.

The drop and the time of recovery can be considerably reduced by using an oversized motor having a higher WR^2 and greater torque capacity. However, on certain installations the characteristics cannot be improved sufficiently by these means without the use of excessively large machines. In cases of this kind, motors of more or less normal design have been applied, with additional WR^2 in the form of flywheels, and speed regulators. The large WR^2 decreases the decelerating rate of the motor under impact and enables the regulator to become effective in forcing the speed back up before it has dropped appreciably. Both rotating and electronic regulators have been used.

The paper describes two installations of this type and gives some of the operating results obtained.

NEW ROD MILL FOR ROLLING STAINLESS STEELS AT RUSTLESS

By EDWARD T. PETERSON
LEWIS W. KING
and
EDWARD C. PETERSON
Birdsboro Steel Foundry and Machine Co.
Birdsboro, Pa.

▲ A brief review of various rod mill installations for the production of stainless rod is given in this paper. Layouts of typical mills and approximate operating data are also presented. The background from which the present mill installation was developed will be reviewed and will be followed by an exposition of the general layout and the various mechanical features of the mill.

Charts are to be shown illustrating the various methods of producing a wide variety of rod, and type of passes used are also given.

The operating characteristics of the mill with regard to production, quality, and crew requirements are presented in some detail.

BLOOMING MILL OPERATIONS AT KEYSTONE STEEL AND WIRE CO.

By WILLIAM HERMAN
Superintendent of Rolling Mills
Keystone Steel and Wire Co.
Peoria, Ill.

▲ THIS paper covers the history and operation of a combination blooming and billet mill built many years ago and the only one of its kind in existence today. It is the sole survivor of two such mills, one built in 1902 and the other in 1917. This type of mill has been operating for the past forty-seven years but being located off the beaten track, it has received little attention and few mill men are aware of its existence.

The basic principle involved, which differs from the conventional practice, lies in the fact that ingots are rolled directly to small billets in one and the same pair of rolls. It performs the double duty of a blooming mill and a four-stand billet mill. This is accomplished by the use of long roll bodies with a set of break down passes in one end and a set of billet passes in the other.

It is a 35 in. two-high reversing mill with a four-pass repeater and a looping floor attached. In one end of the roll the ingot is broken down, in the conventional manner to a 3½ in. square. This square enters the first repeater pass and is repeated four times around the end of the roll and emerges as a 1¾ in. billet nearly 500 ft long. This is delivered to the billet shear by drag rolls where it is sheared to proper lengths for use in the rod mill.

The delivery speeds of all the repeater passes being approximately the same, long loops are formed due to the elongation. At the peak of the rolling cycle, there are three bars in the mill and three loops on the looping floor bouncing over the turtle backs in a spectacular manner that is always viewed with great interest, by the many visitors that enter the plant.

ELECTRIC EQUIPMENT FOR HIGH SPEED 2-STAND TEMPER MILLS

By ROSCOE E. MARRS
Application Engineer, Steel Mill Division
General Electric Co.
Schenectady, N. Y.

▲ THE paper describes the electric equipment for typical high speed two-stand temper mills operating at speeds as high as 5000 fpm.

Note is made of the advantages gained by direct coupling of motors to either back-up or work rolls. The mechanical arrangement of mill and the special design of twin drive motors is described.

Special emphasis is placed on the selection of motors and appropriate booster generators sizes for the pullers and reel drives, the method of rotating regulator tension control for them and the use of a tensiometer for regulating tension between the two mill stands.

The paper also describes essential electrical features of the mill control scheme making use of the rotating regulator as a regulating unit for current, tension and voltage.

POWER SUPPLY AND ELECTRICAL FEATURES OF A 68 IN. HOT STRIP MILL

By F. O. SCHNURE
Electrical Superintendent
Bethlehem Steel Co.
Sparrows Point, Md.

▲ ONE of the problems faced in adding a hot strip mill to a plant's finishing capacity is that of power supply. If the waste fuel situation for the plant is presently balanced, the most economical thing to do is to purchase power. However, if as at this plant, ingot capacity, including a blast furnace, was a part of the expansion program, then additional power generation at least to the extent of the waste gas was indicated.

This mill, although not of an extreme width, was expected to draw a heavy demand upon the power system because it was designed with five roughers to roll 6½ in. x 22 ft slabs. Rolling long slabs means passes of longer duration throughout the entire mill which tends to pyramid the power demands. The normal load will vary from 20,000 to 35,000 kw while that maximum load for wide strip may reach 45,000 kw.

The differential in the time required to engineer and construct a hot strip mill and a power plant presented a problem, which is covered in the paper, of how to operate the hot strip mill before the power plant was completed.

Hot strip mills having become fairly well standardized, there was not much in this mill except its size to present problems of electrical distribution and the paper discusses how this was accomplished by applying load centers.

A flying shear directly driven by a single motor from variable voltage under electronic control is the first of its kind.

All main motors are of the synchronous type, built with high pull-out torque. Motor field regulation is applied to the large motors on the motor-generator sets in order to control the reactive component under light load conditions.

DESIGN AND PERFORMANCE OF MODERN LARGE ROTARY FURNACES

By ANDREW F. KRITSCHER
Development Engineer
National Tube Co.
Pittsburgh, Pa.

▲ THE paper describes the rotary hearth method of heating steel rounds and the pertinent factors affecting design and operation of the large rotary furnaces having a capacity of at least 40 tons per hour.

Heating furnaces employing the principle of the ro-

tating hearth have been known to nearly every branch of the steel and non-ferrous metal working industries for many years but the larger heavy production type of unit is a development since 1940.

Due to the versatility of application and adaptability to a wide variety of conditions, the rotary furnaces presently installed vary in design and operation.

Tests were conducted on furnaces of several different companies in order to study design features and operating practices to not only benefit interested companies by exchange of information, but also to try to establish basic data for future installation through the steel industry.

Since the basic construction of rotary furnaces is relatively simple, the design details of heat control equipment are listed and justification of same is determined. The degree of heat and atmosphere control necessary for heating various types of steels is determined by the type of product heated.

Fundamental operation and scheduling is brought out to be the pertinent requirement for economical results.

Heating curves are presented showing different practices and explanations are given of the unusual shapes of some of the curves.

ROLL DESIGN OF SMALL SHAPES

By WILLIAM H. MOHLER
Superintendent Roll Turning Department
Carnegie-Illinois Steel Corp.
McDonald, Ohio

▲ HOT rolled sections or shapes are a relatively common product of the steel industry. They represent a large and important part of the steel produced. The more common sections such as rounds, squares, flats, rails, and structural shapes are in evidence almost everywhere in the industrial world. But within the large scope of sizes and shapes of sections the greatest variety exists in the smaller intricate types that customarily are rolled on the 8, 10, 12, and 14 in. merchant mills. These are the sizes that try the skill and patience of the roll designer. Sections ranging from small structural shapes to the more intricate sections such as side rings, rim bases, window sashes, hinges, and innumerable miscellaneous items are rolled on these mills. Consideration of some of the problems encountered in the design of the rolls for this type of product will be the basis of this discussion.

Small shapes and sections are generally rolled on mills that are specially adapted to that purpose. The Belgium type mill with two or three high stands, semi-continuous mills, and cross country mills are used. However, the straight, continuous mill has definite limitations for the rolling of special shapes. Hand-fed mills in which the last end of the bar enters the succeeding pass, are the most flexible and, of course, the best suited for the purpose, although not always the most productive. Housings must be equipped for suitable up and down adjustment, lateral and cross axis alignment, and also with suitable entry and delivery guide appurtenances. The designer, in his efforts to produce rolls that will turn out a high quality product to the necessary close tolerance and at the same time maintain a profitable rate of production, is faced with the necessity of keeping abreast of manner and efficiency in which his roll passes are working in the mill, so that this experience can guide him in designing new rolls or altering present equipment. It is well established in the minds of mill men that sometimes a small alteration in the rolls will improve production greatly. In other words, the designer must constantly search for ways of improving the working of his rolls.

Before designing rolls for a new section, consideration must be given to its standpoint of practicability, that is, in respect to the limitations of the mill. Experience has shown that all mills have limitations of sizes and shapes of products beyond which operations become unprofitable. Limitations, as to depth of passes which affects the strength of the roll and width which is dependent of the size billet, must be determined. Other matters, such as thickness of the finished bar, finishing temperature, analysis of material to be rolled, must be taken into consideration. Furthermore, as a result of experience on a particular mill, the designer usually establishes limitations on details like taper, sizes of fillets, thickness and length of stems, flanges, and other features that affect the production of a salable bar.

It is the purpose of the designer to create a series of passes in the rolls which will reduce the bar in cross-sectional area and in stages form the metal into the particular shape desired, at the same time avoiding pinches, underfills, laps, grinding, undue wear and other defects which may develop during the process.

NEW POWER FOR SPARROWS POINT

By J. M. SPENCER
Assistant Fuel Engineer
Bethlehem Steel Co.
Sparrows Point, Md.

▲ AT the beginning of the year, the Sparrows Point plant of Bethlehem Steel Co. put in operation a new power generating station. This station uses steel mill by-product fuels; namely, blast furnace gas and coke breeze, for the production of over 75,000 kw of electrical energy.

Two boilers of 450,000 pounds per hour capacity, with multiple fuel firing, furnish steam at 875 psi and 900 F T.T. at the superheater outlet. The two turbo generators are 30,000 kw A.S.M.E. standard hydrogen cooled machines. All heat recovery equipment associated with the boiler is installed outside, as are the induced draft fans.

The heat cycle is essentially a regenerative cycle with four extraction points, except that a deaerating heater using station exhaust steam has been substituted for one of the extraction points.

An integral part of the station is a pumping system with a capacity of 155,000 gpm for condenser cooling water for other plant equipment.

Gas fuel is piped to the site through an overhead 120 in. gas main, and coke breeze is delivered by rail and transported to overhead bunkers by conveyor belt.

LOOPING AND REPEATING ON MERCHANT MILLS

. . . . the merchant mill described is unique because of the extensive use of automatic operations on the mill . . . .

By W. J. BARRY
Superintendent of Mills
Lebanon Plant
Bethlehem Steel Co.
Lebanon, Pa.

▲ THIS paper describes in some detail how hand looping was replaced by completely mechanized repeating on the 10 in. mill at the Lebanon plant of Bethlehem Steel Co.

This 12-stand mill at Lebanon was started in March, 1926, for the purpose of supplying our bolt, nut, and specialty plant with as large a range of sizes as possible. The range of the mill is as follows:

Rounds—$^{31}/_{64}$ to $1^{5}/_{8}$ in.
Squares—$^{29}/_{64}$ to $1^{1}/_{4}$ in.
Nut bar flats—$^{63}/_{64}$ x $^{33}/_{64}$ in. to $1^{15}/_{16}$ x $1^{1}/_{8}$ in.

As installed the mill consisted of six 16 in. continuous roughing stands, No. 1 to 6 inclusive, two 14 in. stands, No. 7 and 8, in line with the roughing stands, two 12 in. stands, No. 9 and 10, and two 10 in. stands, No. 11 and 12. See Figure 1. All sections are rolled from 4 in. x 4 in. billets, 30 ft long, weighing about 1600 lb. The billets are heated in a continuous furnace, and where necessary, are cut to length on the hot shears before entering the continuous roughing stands.

From Figure 1 it can be seen that it is possible to finish either at stands No. 8, 10 or 12. This arrangement provides considerable flexibility in the range of sizes rolled. The following sizes were all hand-looped from No. 8 stand and on through to the finishing stand:

Rounds—$^{31}/_{64}$ to $1^{9}/_{32}$ in.
Squares—$^{29}/_{64}$ to $1^{1}/_{8}$ in.
Nut bar flats—$^{63}/_{64}$ x $^{33}/_{64}$ in. to $1^{3}/_{16}$ x $^{47}/_{64}$ in.

The mill operators could hand-loop all sizes up to 1 in. round, which finished in No. 10 stand. At this time we were using the conventional oval-to-square method of pass reduction. The billet required to make a 1 in. finishing oval in No. 9 stand is about $1^{1}/_{8}$ in. square and the delivery speed from No. 8 stand, 170 rpm or 620 fpm.

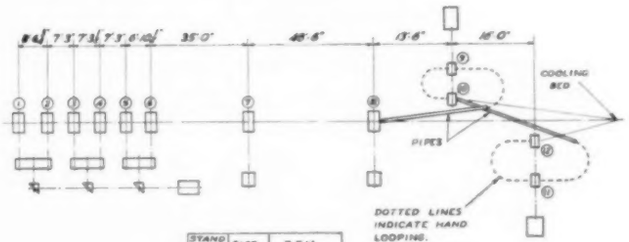
This $1^{1}/_{8}$ in. square was very difficult to hand-loop, and caused many wrecks or cobbles. It was physically impossible for the men to hand-loop any larger sizes than this. Late in 1926 the mill was averaging 16 tons per hour, an output considered very good at that time. However, it was seen that any further increase in tonnage would be unlikely unless the hand-looping could be eliminated. With this in mind it was decided to install a repeater to deliver the bar mechanically from No. 8 to No. 9 stand (Figure 2).

Mechanical repeaters were not new at that time, and were used on some mills for certain sections, but to my knowledge no mill was equipped to repeat rounds, squares or nut bar flats through all the stands. We installed our first repeater on November 23, 1926, and never took this repeater out, regardless of the type of section rolled. This repeater worked so well that it was decided to equip the rest of the mill with repeaters. The repeaters for No. 10, 11 and 12 stands were installed in 1927.

Most repeaters installed in 1926 failed to work properly, because they were set too close to the rolls. Our first repeater (Figure 2) was placed 21 ft away from No. 8 stand. The bar was run through a 4 in. trough, 17 ft long, which is covered for about 14 ft, and then through the open trough and horn trough to the repeater, a distance of 7 ft. This gave the bar ample distance to lift out of the repeater groove, or gutter. If the repeaters are set too close to the rolls or to the twist guides, the bar is held down and is not free to loop out. Correctness of our arrangement was proved by the fact that although we did not have any means to kick the bar out when this repeater was installed in 1926, it has caused very little trouble when repeating bars ranging from $^{25}/_{32}$ in. round to $1^{9}/_{16}$ in. round into No. 9 stand ovals. The other repeaters for No. 10, 11 and 12 stands were placed 10 ft away from the center line of the rolls.

Another reason why most mill men hesitated to equip the entire mill with mechanical repeaters was the

Figure 1 — Layout of 10 in. continuous merchant mill, Lebanon Plant, Bethlehem Steel Co.



STAND NO.	SIZE	R P M
1	16"	16
2	16"	23
3	16"	37
4	16"	52
5	16"	75
6	16"	100
7	14"	112 to 187
8	14"	150 to 250
9	12"	150 to 350
10	12"	180 to 350
11	10"	300 to 450
12	10"	300 to 450

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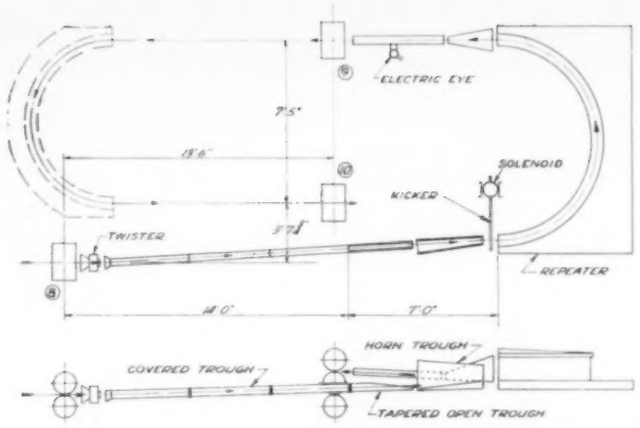


Figure 2 — A mechanical repeater from No. 8 to No. 9 stand was installed in 1927. This handles rounds, squares and nut bar flats.

difficulty in getting the bar to turn up properly to enter the next pass, especially the finishing oval or diamond, or flat and edge passes. Usually attempts were made to turn the bar up at the entry side of the rolls by twist guides or by crossing the oval or diamond, or, if working flats, by putting more work on one side of the bar than on the other, in other words, by distorting the bar to give it the proper twist without any positive control of the bar, which usually results in wrecks or cobbles. To avoid this trouble we installed a pair of twister guides on the delivery side of the pass, 2 ft. 6 in. from center line of the rolls. These twister guides are adjustable by set screws so that the twist of the bar can be changed without shutting down the mill. The guides are set up so that there is at least $^{3}/_{32}$ in. clearance between the bar and the guides. This is done in order not to place too much friction on the bar and to prevent it from buckling back of the twist guides, which would cause the bar to wreck and pancake back at the point of the delivery guide. The twist guide is set at about 17 degrees between No. 9 and 10 stands. From this angle the guides can be adjusted for more or less twist, as needed. In using the oval-to-square method of reduction, it was necessary to twist or control the square entering the oval, as well as to turn up the oval into the square. This required a twist guide at No. 8, 9, 10 and 11 stands. By changing over to the oval-to-round method of reduction, there was no need of controlling the round entering the oval pass, and this eliminated the twist guides at No. 8 and 10 stands.

The Lebanon mill stands No. 9 and 10 are driven by the same pinion stand (Figure 1). This created a problem in controlling the kick and speed growth of the bar. The reduction of area from the strand round to strand oval varies from 24 to 30 per cent, and from strand oval to strand round from 15 to 24 per cent. This caused too hard a kick when the bar hit No. 10 stand, and the loop growth was too much to be taken care of. To cut down the severe kick of the bar out of the repeater, we had to reduce the roll diameter in No. 9 stand about ½ in. below the pitch diameter, and increase the diameter of No. 10 stand rolls about 1 in. This cut down the loop growth and decreased the severity of the kick. On the newer mills this is taken care of by individual variable-speed motor drives.

One other serious trouble with the mechanical repeaters was the double kick of the bar. This occurs when a new order is started or if the speeds are not set just right, or if the entry trough to the repeater is out of line, in which cases the bar will fall back in the repeater groove and make the second kick, which usually results in a wreck or cobble. Our repeaters are all stationary, but the entry troughs on all are movable so that they can be lined up with the delivery pass. Repeaters installed today are movable and can be lined up with the delivery pass. To prevent this double kick, a kick-out lever was installed. When the bar enters the receiving set of rolls the entry guide closes on it, while at the same time, the kicker arm comes up and raises the bar out of the repeater groove and holds it out until the last end has passed through the receiving set of rolls, see Figure 3.

If the speeds are not right or if for some other reason the bars should not loop out properly, the kicker arm will lift the bar and hold it out until the proper adjustments are made. The kick-out lever also serves another purpose in that the roller, to get a test piece, can kick the bar out of the repeater before it enters the next pass, or if there is a wreck on the mill the bar can be raised out of the repeater at the most convenient place.

The repeaters seem to work just as well up or down from one stand to the other. For instance, the bar is delivered from center line of the top and middle roll on No. 9 stand to the center line of the bottom and middle roll in No. 10 stand (Figure 3). This is a drop of 12 in. From No. 10 stand to No. 11 stand is a rise of about 10 in., and from No. 11 stand to No. 12 stand a drop of 10 in. As long as the rise or fall of the bar is uniform from the delivery rolls to the receiving set of rolls, the bar will loop out without any trouble.

With increased tonnage due to the use of the mechanical repeaters, the chilled-iron entry guides became a constant source of trouble. These guides did not hold up for more than 50 to 75 tons before they had to be replaced and the roller was constantly adjusting them to take up the wear. To change the entry guides on a round is like changing the pass; it takes several trial pieces before section can start again. To overcome this we began using nickel-chrome steel guides. All entry guides are now made of this material and they stand up for 2500 tons, or about 50 times as long as the old type chilled-iron guide. Later we built our own roller guide box, with the opening and closing feature. This solved the problem of the entry finishing guides and scratched bars.

While the mill was hand-looping, we had a tight and loose guide on the finishing stand, manually-operated. With the addition of the repeaters, the snap-guides were continued in No. 10 stand when the bar was finishing in No. 12 stand. The open guide on a mechanically-fed mill is very important, especially on the finishing stand where the guides must be set up close to the bar to keep it from leaning, whether a roller guide box or the regular button guide is used. On the small sizes the billet must be sheared to length at the hot shears before it enters the roughing rolls, and on these sizes the sheared ends sometimes produce a scrappy or split end on the finishing oval. We do not have a shear to crop the front end before it enters the finishing pass, the tight guide will not let the scrappy or split end

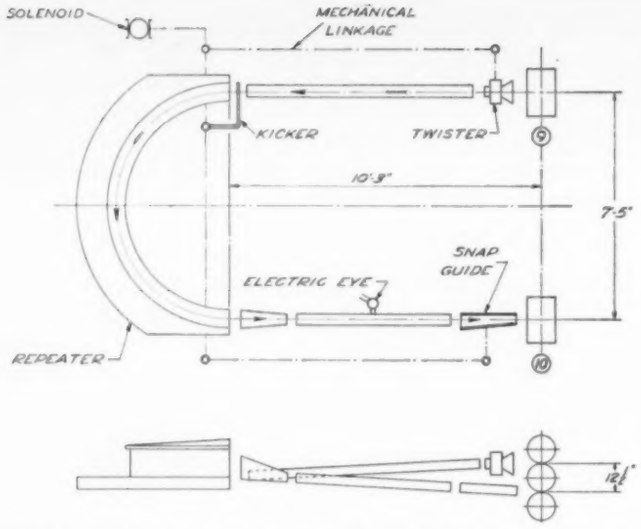


Figure 3 — A kick-out lever was installed between stands No. 9 and No. 10.

enter the rolls. This results in a cobble, not only of the bar that is wrecked, but also of the next bar already in the roughing rolls. This loss of perfectly good steel on account of a bad end shows up in higher cost and lower yield. If it is necessary to have tight and loose guides on a hand-looping mill where the bar is not lost the instant it is stopped, it shows the value of this arrangement in a mechanically-fed mill where the bar is cobbled the moment it hesitates.

The operator opening and closing the tight and loose button guides was also causing wrecks or cobbles, either by being too slow in closing the guides, letting the front end of the bar turn down and having 3 or 4 ft of a crop at the trimming shears, or by being too fast in closing the guides before the bar entered the rolls. This was a very dangerous place for a man to work, with the rolls traveling 435 rpm, giving a delivery speed of 1100 fpm. The next step was to have the guide lever mechanically-operated. This was done by the use of solenoids and flags. The bar running under the metal flag raises the flag switch which in turn cuts the current in the solenoid, and with the downward stroke, sets the shaft in motion to close the guide. After the bar is through the rolls, the solenoid is reset and the guide is open and ready to receive the next bar.

The first electric eye was installed on the Lebanon 10 in. mill in October 1930, to control the operation of the rotary shears. The electric eye took the place of the troublesome metal flags which pressed on the bar, tending to scratch it. Furthermore, the flags, when worn, sometimes held the bar and prevented it from kicking out properly onto the cooling bed. The flag mechanism was also difficult to move when changing the length of bar being cut, while the eye can be moved between bars without shutting down the mill. From this single installation, which was the first application of the photo-electric cell on any rolling mill, as far as we know, has been developed all the other uses of the electric eye on the mill.

The success of the electric eye as applied to the rotary-shear operation led to its adoption for other uses. Early in 1931 the metal flags which controlled the operation of the solenoid in opening and closing the movable entry snap-guides or button guides were replaced by electric eyes. The solenoid which causes the movement of the entry snap-guides, also operated the twister guides and the kicker used with the automatic repeaters to kick the bar out. Figure 4 shows the mechanical linkage necessary to accomplish this. The operation is as follows: the bar passing beneath or in front of the electric eye causes the solenoid to drop. This solenoid is linked to a shaft which turns a screw, thus tightening the guide. On the shaft is a lever which transfers the motion, thus releasing the twister guides, and lifting the kicker. One electric eye controls all three operations.

On the finishing stand the same eye operates the signal lights which indicate to the man who enters the billets into the first pass of the roughing rolls when the bar enters the finishing pass, when it leaves the pass, and how close it is safe to follow with the next billet.

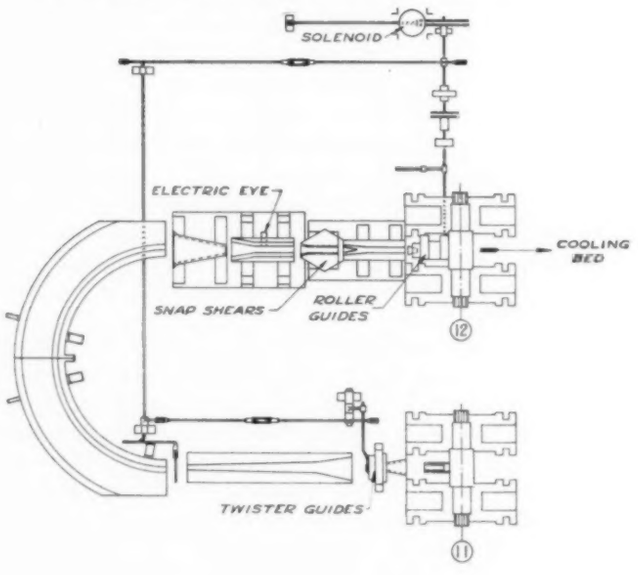
On December 12, 1931, we installed our first fiber bearing which proved to be a Godsend to the continuous mills. With the mechanical repeaters, there is a bar going through the mill every minute of rolling time. For instance, on November 30, 1947, rolling $\frac{7}{8}$ in. round, this mill averaged 54.8 tons per hour for the entire turn, and on the following day, December 1, 1947, rolling $\frac{55}{64}$ in round, the average was 56.1 tons per hour for the turn. This means that a 1600 lb billet was passing through the rolls every 52 seconds. Without the fiber bearing, the roller could not have kept this section within gage at this rate.

The following is a comparison between brass babbit grid bearings and the fiber bearings:

1. Brass bearings averaged 4400 tons.
2. One fiber bearing is equal to 112 brass bearings.
3. $\frac{1}{64}$ in. wear on a fiber bearing is equal to 2½ brass bearings.
4. The average tonnage for 12 fiber bearings for each $\frac{1}{64}$ in. wear amounted to 11,347 net tons.

In 1935 we installed the fifth repeater (Figure 5). This was necessary in rolling $\frac{31}{64}$ and ½ in. round from a 4 x 4 in. billet with only 12 passes to finish this

Figure 4 — An electric eye is used to control the operations between stands No. 11 and 12, and also tells the operator when to enter the next billet.



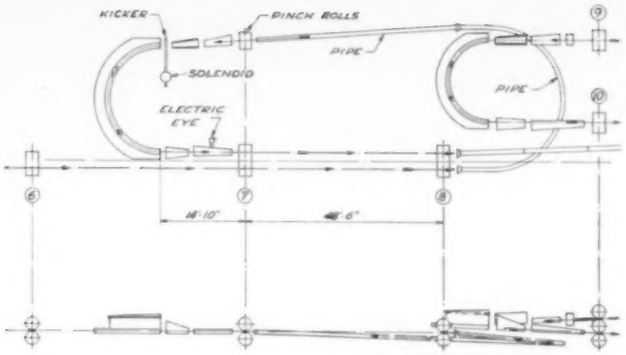


Figure 5 — Double repeating is used between No. 8 and 7 stands. This was the last repeater installed on this mill.

small size. The only way to get two more passes was to repeat back through No. 7 and 8 stand, a distance of 48 ft. To do this we had to send the bar through a 2½ in. pipe, back to No. 7 stand, through a set of pinch rolls, to the repeater. This we wanted to do as quickly and as cheaply as possible. We had no pattern, so we decided to make a repeater from ½ in. boiler plate. To keep it from warping we ran water between the plates, and after 12 years this repeater is as good as any cast-iron repeater we have. This change increased our tonnage on ½ in. round from 13 to 17 tons per hour, or about 30 per cent.

The mill was flexible, as mentioned before we finished out of No. 8, 10 and 12 stands. The oval-to-round method adds to the flexibility of this mill over the oval-to-square method with the sizes that can be rolled in combination. For instance, the 1⅜ in. round is finished in No. 8 stand. This 1⅜ in. round is a perfect billet for 1 1/16 in. oval in No. 9 stand for finishing 1 1/16 in. round on No. 10 stand, and the 1 1/16 in. round is a perfect billet to make the ⅞ in. finishing oval on No. 11 stand and finishing ⅞ in. round in No. 12 stand. When an order for 1⅜ in. round is rolled, the trough leading to the cooling bed is changed and connected to the No. 9 stand repeater, and without any other change the 1 1/16 in. round is rolled on No. 10 stand. With this order finished the trough leading to the cooling bed is changed and connected to the No. 11 stand repeater, and the ⅞ in. round order is rolled on No. 12 stand. This idea of combinations can also be applied to some of the nut-bar flats finished on No. 10 and 12 stands. This flexibility permits the rolling of small tonnage orders without too much delay in roll or pass changes during the turn.

Mechanical repeating with the other improvements raised the output of the Lebanon mill from 16 tons per hour, with hand-looping in 1926, to an average of 27 tons per hour for the year 1947, an increase over hand-looping of 69 per cent for all grades of bars. This is not a fair comparison, though, because the tonnage rolled in 1926 included extended runs of one size, while the tonnage quoted for 1947 was for normal operation of the mill, which today means 60 to 80 sizes per month over the whole range of the mill, against 10 to 20 sizes over the limited range of 1926.

In December of 1947 the average production was 31 tons per hour, which is a record. The yield for 1947 was 96.56 per cent for all grades.

DISCUSSION

PRESENTED BY

H. A. CARTER, Superintendent, Roll Department, Bethlehem Steel Co., Lackawanna, N. Y.

W. J. BARRY, Superintendent of Mills, Lebanon Plant, Bethlehem Steel Co., Lebanon, Pa.

R. E. FINLAYSON, Superintendent, Alloy Bar Mills, Carnegie-Illinois Steel Corp., Chicago, Ill.

JAMES N. IMEL, Superintendent, Rolling Mills Department, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

E. C. PETERSON, Engineer, Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

S. A. SMITH, Superintendent Merchant Mills, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

H. A. Carter: I think you will all agree with me, in stating that Mr. Barry has a 10 in. bar mill that is probably the most unusual in the country I have seen the mill, rolling rounds and nut flat stock and after observing the methods devised, to turn up ovals and flats, as well as repeating, I am convinced that any mill that has not too large a variety of sections, could be made as automatic as Lebanon's 10 in. mill. I would like to ask what happens, if an electric eye failed, as they must do, sometimes?

W. J. Barry: You will notice, we have the second electric eye, on all stands, in case one would fail. The only time they fail is when they burn out or get a bad connection. We consider them pretty nearly fool-proof.

H. A. Carter: Regarding the diamond square reduction method, I notice you have changed yours to the oval round method, to simplify the use of repeaters. My question now is: "Will repeaters, similar to yours, work satisfactorily on the diamond square method all the way through the mill?

W. J. Barry: Yes. We repeat a diamond into a square sometimes, in No. 12 stand. All you would need, to work the diamond square through the mill, is just that many more electric eyes and twist guides.

H. A. Carter: What is the largest round that you think could be repeated on a 12 in. mill? Do you think you could repeat a 2 in. round?

W. J. Barry: Yes. I believe you could if the repeater and equipment would be made heavy enough. We now repeat a 1 9/16 in. round.

H. A. Carter: Do you protect roll passes from rust, with a preservative and if so, do you clean it off before putting roll in mill? The reason for this question is that usually the preservatives put on rolls hinder the rolls from biting the bar promptly, and we find that the slightest entering hesitation of a bar being repeated, invariably causes a cobble.

W. J. Barry: We use shellac to paint our rolls, but they are always cleaned before placing in mill. If we did not we would more than likely cobble the first bar.

H. A. Carter: You mentioned the use of nickel chrome entry guides, as well as some roller guides. Do you think you will eventually replace the solid nickel chrome guides with roller guides throughout your mill?

W. J. Barry: I do not believe we will. We do not roll any high speed or alloy steels and therefore see no reason to replace the nickel chrome guides with roller guides, except on the finishing stands.

H. A. Carter: That is all the questions I have, but there is a question most mill men in the audience are thinking: "How many men have these automatic devices eliminated in the mill?" The day I was in your mill we saw only the roller and a few operators and the remark was made: "Who makes your roll changes?" Repeaters certainly would not eliminate roll changes.

W. J. Barry: The repeaters do not eliminate the roll hands. These men are available for other jobs on the mill such as spell men and shipping labor. When there is a roll or pass change these men make the change.

R. E. Finlayson: Is there any relationship between the size of the bar being looped and the radius of the loop? In other words, to handle a 2 in. round, the mill stands should be spaced further apart than for the smaller bar.

W. J. Barry: The present range is $3\frac{1}{64}$ in. to $1\frac{9}{32}$ in., you must have a $1\frac{9}{16}$ in. round to make a $1\frac{9}{32}$ in. round. That is as far as we have ever gone.

R. E. Finlayson: Then you have not as yet calculated the loop required for the heavier 2 in. bar, but you feel that there is a definite ratio of bar size to the spacing of stands that must be anticipated?

W. J. Barry: Yes.

R. E. Finlayson: Do you get any scratching from these repeaters?

W. J. Barry: No, not from the repeater. They get so smooth they would not scratch anything. Your apron might scratch if you let it get worn in, but as for a cast iron repeater, the more you use it the smoother it gets.

James N. Imel: From your experience on fiber bearings, the fiber bearing life is considerable. I would like to ask what are the water conditions and what degree of neck coverage is there on the bearings to get that kind of bearing life?

W. J. Barry: We have some pretty good water springs, spring water mixed with creek water is used most of the time. I would say the water is fairly decent but I do know if you have any pickle tanks around and let it run into the stream and use that water, you will not be able to use fiber bearings because it rusts the necks and pits them, I also want to say one thing, if you want to put in fiber bearings, never put them in on an old set of roll necks. Try them out on a ground neck. You need a polished neck to work fiber bearings. I have said that from the very start and we have proven it. The fact of the matter is we put a fiber bearing in on No. 8 stand, the first one we tried, and on that particular stand we had to have a fire hose on it to finish out the turn. It wore so fast it burned up.

James N. Imel: On your neck coverage what degree do you use?

W. J. Barry: I think that is about 102 to 112 degrees.

James N. Imel: On your roll necks, what degree of the neck do you cover with fabric bearing?

W. J. Barry: I think it is about 28 to 30 per cent.

E. C. Peterson: I would like to ask about this repeater that is shown going from No. 8 back to No. 7.

W. J. Barry: We deliver the bar back from No. 8 stand a distance of 48 ft through a $2\frac{1}{2}$ in. pipe to No. 7 stand repeater, and repeat the bar the same as on any other stand.

E. C. Peterson: You speak about water cooling on that repeater. Do you have a jacket or do you just pour water in the trough?

W. J. Barry: We run the water inside the repeaters, not in the trough but in a jacket around the trough.

E. C. Peterson: Do you think that in a fabricated repeater, cooling is absolutely necessary or have you had any exeprience without cooling?

W. J. Barry: We did it on account of warping. It may not be necessary on small sizes. I do not know.

E. C. Peterson: We have made fabricated repeaters without cooling, and we seem to have no warping, but maybe you have a larger size bar. One other question: When one bar follows right after the other and your kicker is up, what returns the kicker into place? In other words, if one bar comes right after the other is there some danger of cobbling?

W. J. Barry: If you follow too close, yes. We have something very interesting. We have three signal lights connected to the electric eye on the finishing stands which indicates to the man entering the billets into the continuous roughing just how fast to follow with the next billet. These lights are set at $2\frac{1}{2}$ second intervals, and by means of these lights he can judge the speed of entering the billet into the rolls without causing cobbles or wrecks.

Member: What effect does the temperature of the water have on the fiber bearings?

W. J. Barry: I would not advise using water that is too hot. Our water runs about 68 to 74 F. Clean water is more essential than the temperature of the water. You can get along with warm water, not hot water, but when you have dirty water it is no good. It will clog up the pipes and stop the flow of water on the necks, and your bearing will burn up.

Member: We run about 74 F, I thought that was too high.

W. J. Barry: No, it is not too high.

James N. Imel: Do you use a filter for the lubricating water for your composition bearings?

W. J. Barry: No, the only thing we have is screens to keep the dirt out of the line. There is one thing I will say about the electric eye. Do not try to put an electric eye in your mill without having a water jacket around it. The temperature changes the action of the photo electric cell. In other words, when you put in an electric eye, put a water jacket around it and have disks so that you can clean them, so the water will not get near the eye. You can always use air to keep them cool but any change in temperature does change the action of the electric eye. It will make it work faster or slower.

S. A. Smith: We are trying out on the 9 in. mill, the repeating of flats from the flat up to the edge and in some cases we have been successful in repeating that flat down to the plain roll. We found this out on repeating flats from the edge to the flat, that the only time we have been successful was when using a high carbon steel. When we use a low carbon steel the repeater takes the twist out. What sections are you repeating on your repeater? We have no trouble with ovals or diamonds.

W. J. Barry: $^{63}/_{64}$ by $^{33}/_{64}$ in., up to and including $1^{3}/_{16}$ in.

S. A. Smith: Do you put a fluted square around the repeater on No. 8 to No. 9 stand?

W. J. Barry: No. The flute is in No. 7 stand, enters No. 8 stand flat. Going from No. 8 around to the edging to No. 9 stand, the bar is turned up to enter the edging pass.

S. A. Smith: What do you take from No. 8 to 9?

W. J. Barry: Flat from No. 8 to 9, then on edge from No. 9 to 10.

S. A. Smith: You are edging at No. 9?

W. J. Barry: That is right.

S. A. Smith: How do you turn it down from No. 9 to 10?

W. J. Barry: With the twister guide, the bar wants to go around the repeater just the way it comes out of the edging pass, so we must turn it down with the twister guides.

S. A. Smith: Perhaps this is the answer to my problem. The distance that you have from the delivery of your No. 8 stand to No. 9 stand, how far is that?

W. J. Barry: From No. 8 will not do you any good. You have to take from No. 9 to No. 10 stands. The repeaters are all set ten feet away from the rolls and the bar runs through a trough to the repeater.

S. A. Smith: We have had this difficulty, when I come off the end of the repeater, going around the repeater took out the twist I put in it. We use no kick-off delivery.

W. J. Barry: The most natural thing for an edging pass is to go around the repeater just the way it comes out of the pass. What you have to do is knock it down. Try turning the bar the opposite way.

S. A. Smith: You mean you can put a twist in the bar and hit the repeater in the top side?

W. J. Barry: Yes.

S. A. Smith: I have never been successful in doing this. I have always had the bar hitting the repeater in the bottom.

W. J. Barry: Yes, we have done that many a time. I do not see why it should want to turn up after it leaves the repeater. If you start turning down, put enough twist in it or maybe you are putting too much twist on it and the bar is turning over the second time. Most people put too much twist on it. The actual twist around that No. 9 repeater for ovals is only nine degrees. The reason we must put 17 degrees is because we have $^{3}/_{32}$ in. clearance. We never set our twist guides right down on top of the bar. We always leave a clearance in there of $^{3}/_{32}$ in.

GARY BUILDS NEW TERNE-COATING LINE

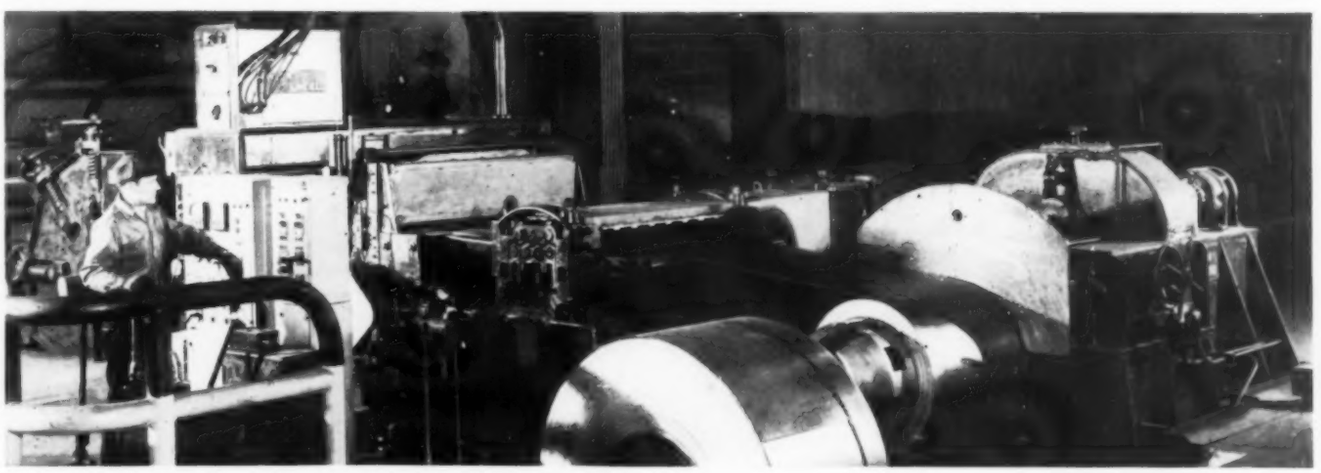
▲ A new continuous terne-coating line, which will produce a better quality sheet steel for the automotive and agricultural industries, is nearing full production at Gary (Ind.) sheet and tin mill of Carnegie-Illinois Steel Corp.

The 260-ft line at this plant employs a new electrolytic pickling bath, which is the first installation of its kind ever to be used in conjunction with the operation of such a production line.

Replacing an old installation, the new terne line is out of the experimental stage and approaching its rated capacity. It is currently capable of coating coils up to 48 in. wide and weighing up to 48,000 pounds in gages from 16 to 26 with eventual capabilities of processing somewhat lighter gages.

The wide strip travels on a continuous basis through the new electrolytic pickling unit and a water scrubber operation, then through a zinc-ammonia chloride flux, passing on through a hot terne mix coating bath composed of 90 per cent lead and 10 per cent tin. It emerges through a hot palm oil bath and a vertical dry cleaning machine ready to be sheared or coiled and packaged for shipment.

Out of the experimental stage, into full production, is the new terne-coating line at Gary Sheet and Tin Mill of Carnegie-Illinois Steel Corp. The 260-foot production line is the first of its kind to employ a new electrolytic pickling bath.



EQUIPMENT FOR EXTRACTING

. . . . the stripper crane in its daily operation is required to exert enormous forces, some as high as 1200 tons . . . .

▲ OF all the equipment that the crane manufacturer is called upon to construct, perhaps the most interesting is the stripper crane. It is the "brute" or "muscle" of the crane field. Thousands of pieces go together to make up its construction. Where normally one thinks of a crane in terms of lifting ability, this does not apply to a stripper crane.

The normal lifting capacity on a stripper crane is on an average of 40 tons live load, or a total of about 65 tons when one includes the weight of the stripping mechanism. Its main strength lies in its ability to exert a force up to about a maximum of 800 tons on a 200-ton rated stripper.

There have been a number of tests made to determine the actual stripping forces required for removing ingots from the molds. A hydraulic operated gage supported from the links, with lugs similar to those on the molds, was used to measure the forces. For example one test was made using a 135-hp motor, frame 416, 410 rpm, 230-volts, d-c. The pressure reading on the first point of the master control was 200 tons, second point of master control was 300 tons, third point of master control was 380 tons, fourth point of master control 410 tons, and fifth point of master control 800 tons.

One can readily see that the machine must be very well constructed in order to withstand this force, and deliver satisfactory service throughout its life, whose life must compare favorably with all other types of heavy steel mill equipment.

The functions of the stripper crane are as follows:

When the molten metal from the open hearth furnaces has been poured into the molds to cool, it forms an ingot. The problem of extracting this ingot from the mold is the duty of the stripper crane. This problem, however, is not as simple as it may first appear, because there are several types of molds and ingots. There are the big-end-up with hot tops, the big-end-down and big-end-up flush type. The molds vary in size and design. The hot tops follow no particular standard. The stripper crane then must be so designed that it can handle this wide variation.

The general design of the stripper crane shown in Figure 1 includes a one piece fabricated trolley frame, a combination worm and spur gear trolley drive, a combination worm and spur gear hoist drive, and a combination worm, spur gear, and screw drive for the stripping mechanism. There is a large round fabricated steel shell and guides in which the stripping mechanism is held in its upward and downward travel.

Included in the stripping mechanism is the "bull-nose" for pushing the ingot from the mold, and the "tongs" for gripping the ingot and pulling it from the mold. Co-operating with these two are the"links" which hold the mold in either direction.

It is in the design of the "bull-nose," "tongs," and "links" that the greatest care must be exercised. Correct data must be obtained from the purchaser on mold sizes and hot top design on all molds that will be used.

The gripping range for the tongs is very difficult to determine since hot tops vary in angularity where the bits must engage them.

In designing the tongs an effort is made to have the travel of the tongs such that with the bits engaging the hot tops, there will be an upward motion. Thus as the tongs grip, there is a tendency to pull the ingot from the mold. Should this upward motion not conform to the slope of the hot top, the bits will slip from the ingots causing the bits to break, (see Figure 2). The mold manufacturer must give this serious consideration when standardizing on the hot top molds.

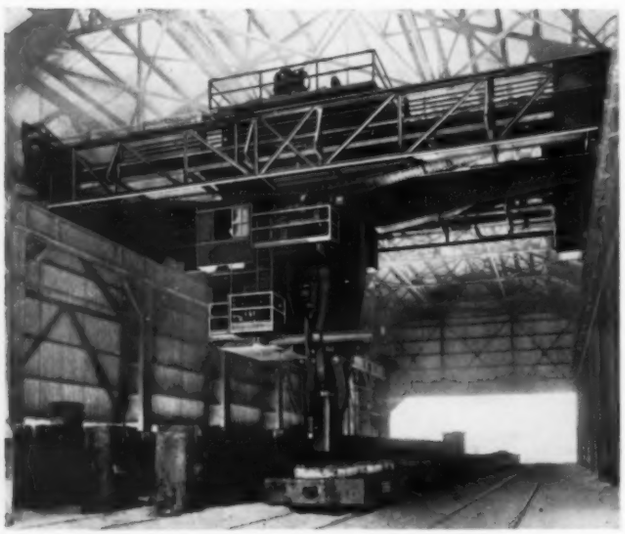
Locating the lugs on the side of the molds should also be given careful consideration, particularly with the big-end-down ingot molds.

When stripping ingots having hot tops it is necessary that the links clear the lugs on the side of the mold. This allows the holding-down mechanism, located approximately half way up the links, to come into play. Should the lugs on the mold be flush with the top or close to the top of the mold, they may prevent the holding-down mechanism from engaging the mold. Should this mechanism not engage properly, the crane is then pulling against itself. This causes the bits to break or have a very short life.

Where molds have such lugs as described above, it is possible to design a link to handle the situation. However, the links are cumbersome and not desirable.

When designing the pull tongs, there should be a ratio of not less than 1.25 to 1 between the range and the drop. This ratio will permit the proper gripping force used in removing the ingot from the mold (see Figure 2).

Figure 1 — The stripper crane is unique in the steel mill and has been designed especially for its particular function.



Presented b. are AISE Annual Convention, Cleveland, Ohio, September 30, 1948

INGOTS FROM THEIR MOLDS

By H. W. BALL
Assistant Chief Engineer
The Morgan Engineering Co.
Alliance, Ohio

Much thought, together with actual tests, has been given to the bits used on the tongs for gripping the ingot. Hardened bits tend to break. This is very likely due to the extreme heat encountered. One steel plant, using bits of special alloy steel, was able to use these bits for a period of eleven months, handling approximately 15,000 pieces. The replacement was made only when the bits had been ground to a point beyond further utility.

The lubrication of this machine is very important. The screw shaft must be provided with adequate lubrication at all times, if one is to avoid costly replacements.

The screw shaft is designed with both right and left hand threads cut on it. On these threads operate two heavy bronze nuts. The shaft together with the nuts are mounted in what is commonly called a barrel. The stripper barrel is a one piece casting and should be kept filled with oil. Drilled holes in the bronze nuts and the screw shaft, allow the lubricant to reach the necessary points, thus holding wear in the mechanism to a minimum.

In recent years air conditioning has become an added feature in the operator's compartment. To accommodate the air conditioning unit, there is provided eight to ten inches of insulation under the floor along with two inches of insulation throughout the inside of the cage, with the exception of the space for the windows. To maintain the efficiency of the air conditioning unit, double panes of glass are used in all windows. The air conditioning unit itself is usually mounted directly above, or along side, the operator's compartment.

The correct procedure on the screw type stripper for stripping ingots is as follows:

The links are lowered over the mold, the links close and engage the mold lugs and then the entire mechanism is hoisted. This operation will lift the mold, leaving the ingot on the car, provided the same is not a "sticker." This is an expression used to describe ingots that are difficult to remove. Should the ingot prove to be a "sticker," the mold and ingot should be lowered to the car, and the stripping mechanism started. As soon as the stripping ram comes in contact with the ingot, the stripping unit with links and mold will be automatically lifted by the screw, thus freeing the mold from the ingot, the counterweight automatically taking up all slack in the cables. As soon as the mold is free from the ingot, the stripping mechanism should be stopped and the rope hoist used for further lifting of the mold.

Some operators form the habit of lifting the mold and ingot from the car, then if the ingot does not free itself they start the stripping ram and push the ingots out. This allows the ingot to drop and may cause a broken axle or fractured bearing on the car. The blame for such a situation can be placed with the operator as there is no necessity for dropping ingots on the cars.

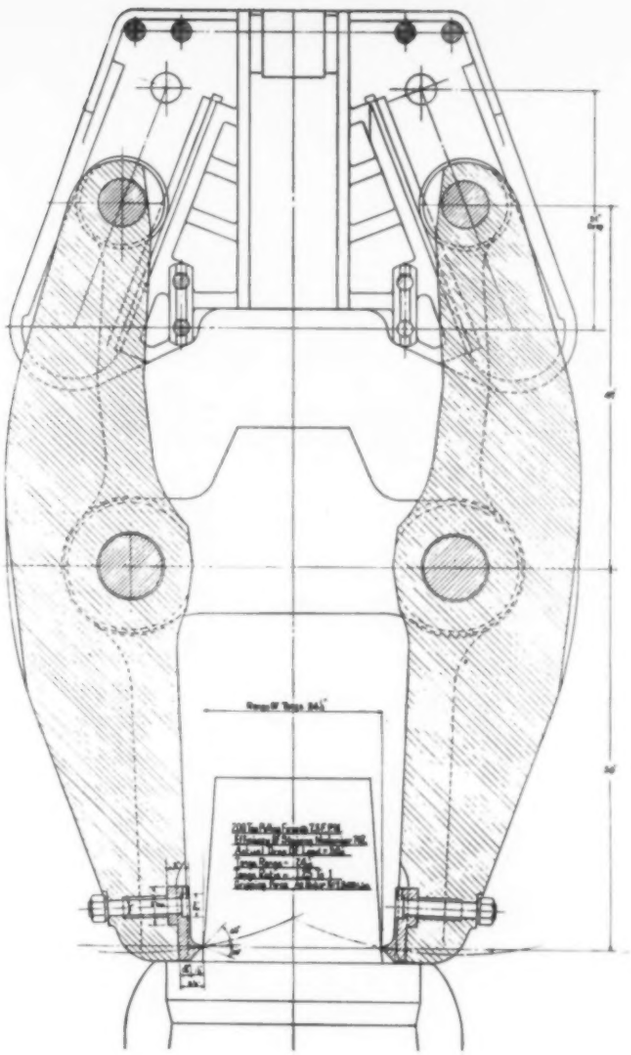


Figure 2 — Care is required in the design to insure that the bits do not slip from the ingots.

On the combination type of stripper for stripping big-end-up and big-end-down ingots one should lubricate the screw by occasionally driving the screw to its full travel in both directions.

Electrically operated stationary ingot strippers — Along with the overhead strippers, some of the steel mills require stationary strippers (see Figure 3), for stripping inverted molds. They are usually 100-ton, 150-ton, or 200-ton capacity. The operation of these strippers is very similar to the overhead type. They only strip the inverted type of ingots. The ingots are placed on a fabricated welded steel frame of heavy construction. This frame is mounted on the floor and the machine proper lies below this frame in a pit. The mold is placed on the platform while the links are in the open position. The motor is started. This automatically closes the links, clamping the mold to the platform.

The stripping screw, to which the "bull-nose" is at-

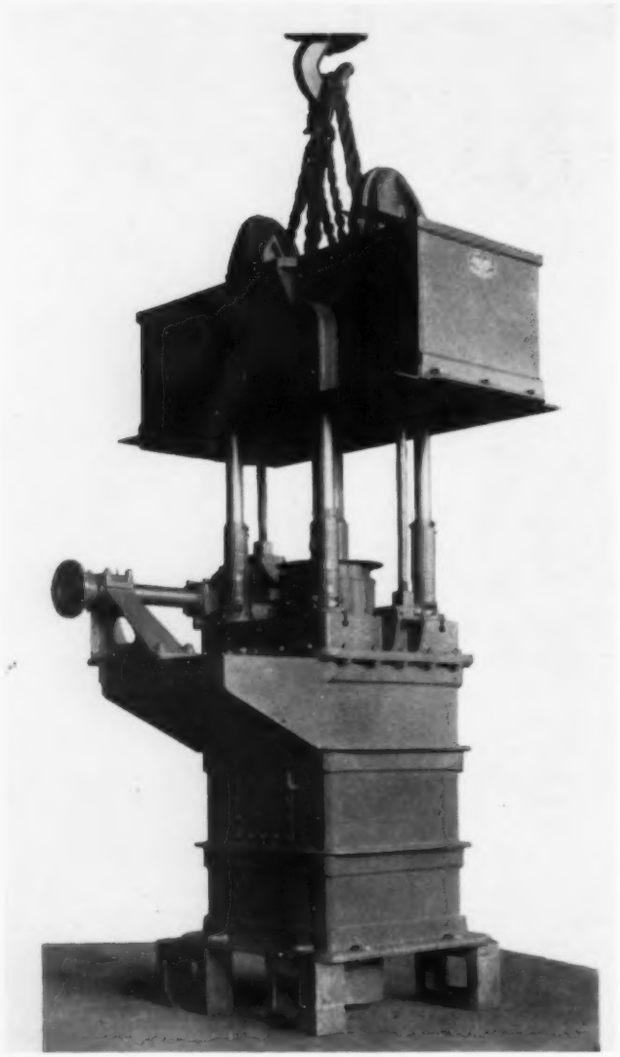


Figure 3 — Stationary strippers are commonly used for stripping ingots in inverted molds.

tached, automatically rises, thus forcing the ingot up in the mold. The motor is then reversed and the "bull-nose" returns to its original position, during which time the links automatically return to their open position.

The base, or main housing, which acts as an oil reservoir, contains the principal moving parts of the machine. The housing is constructed of structural steel sections welded together.

The stripping motion is accomplished by means of a bronze sleeve with internal and external threads and operating on a nickel steel screw. The upper end of the screw is square and passes through a bronze bushed opening in the cover.

The steel drive gear is keyed to the bronze stripping sleeve, and, as the sleeve is threaded in a steel nut attached to the crosshead, the rotating movement of the sleeve will cause both sleeve and screw to move vertically.

The cast steel threaded nut is securely fastened to the crosshead which carries the forged steel connecting bolts for operating the mold links.

The motor drive is mounted on a separate welded fabricated base, and is coupled to the stripping mechanism through a flexible coupling. The motor gear is of the safety slip type to protect the motor from becoming overloaded.

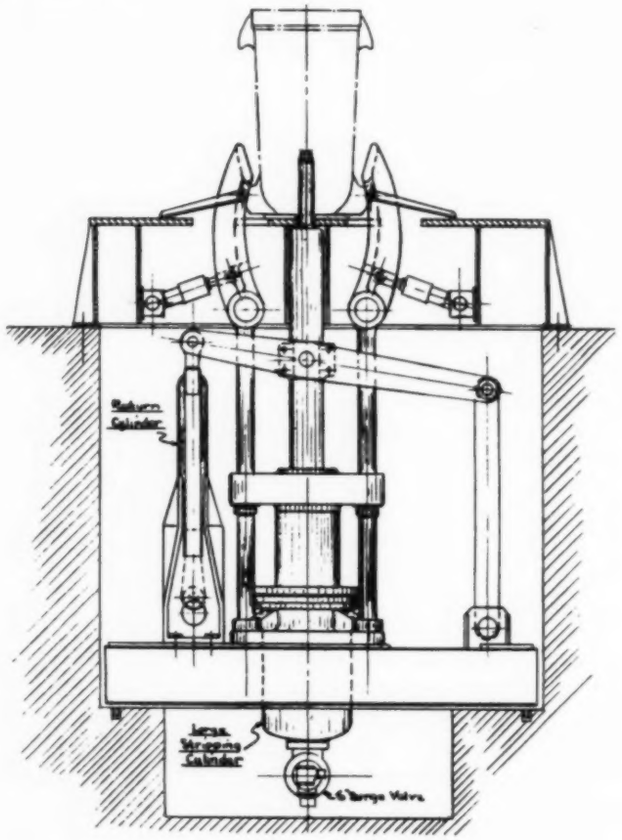
Hydraulic-operated stationary ingot strippers—It is the writer's opinion that when strippers have a capacity of over 200 tons they should be of the hydraulic-operated type. This can be either overhead or stationary (see Figure 4).

Recently a steel plant purchased a 400-ton hydraulic-operated stripper. This stripper is to be mounted in a pit below the floor level. The main cylinder is of steel cast construction, securely bolted to a steel frame, and composed of structural steel sections welded together.

The main 21 in. diameter operating cylinder, having a stroke of two feet and a stripping speed of one fpm, is supported on a fabricated base. It is held in place by the four columns supporting the holding links. In addition to the main cylinder there is a 5 in. diameter pull-back cylinder having a stroke of 3 ft-3 in., and a return speed of 10 fpm, the function of which is to return the "bull-nose" to its lowered position. There are also two 4½ in. diameter hydraulic cylinders, having a stroke of 5 in., which open and close the links.

The pump operating the hydraulic system is driven by a 30-hp motor operating at 900 rpm. This pump maintains a pressure of 2500 psi. The hydraulic pump and motor are mounted on a separate foundation convenient to the stripper. Assuming that the machine is idle, the links will be in the closed position. Upon application of the hydraulic pressure to the link operating cylinders, the links will open. The pull-back plunger will be forced down, and the machine is ready to re-

Figure 4 — The hydraulic design lends itself to use on large strippers.



ceive the mold and ingot. Then the link operating cylinders close the links and pressure is applied to the large plunger forcing the "bull-nose" against the small end of the ingot.

Upon extraction of the ingot all movements are reversed.

The links for gripping the mold, the dust guards, and the "bull-nose" are the only parts of the machine which extend above the platform supporting the mold. The "bull-nose" may be removed by driving a tapered key out of the lower section. The top of the platform on this particular machine is located three feet above floor level.

The openings in the top platform for the links are

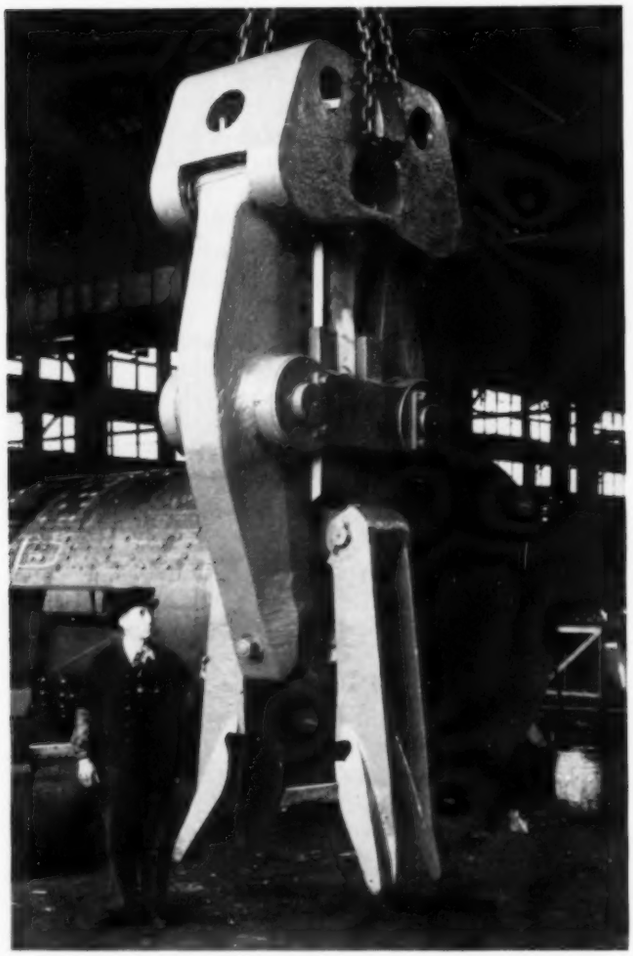


Figure 5 — An auxiliary stripping unit is available which can be readily attached to a regular stripper crane for stripping big-end-up ingots with hot tops.

provided with sliding covers attached to the links to keep all foreign matter from dropping into the pit. There is a telescopic metal guard enclosing the upper part of the main plunger which prevents gritty substances from entering the main cylinder.

At the present time, a design is being developed for stripping both big-end-down and big-end-up ingots. This will then allow stationary strippers to perform nearly all of the functions of the overhead type stripper.

Auxiliary or hook-on type of ingot stripping mechanism—Some of the steel plants having the standard overhead stripper for stripping big-end-down ingots only, purchase what is known as an auxiliary stripping unit,

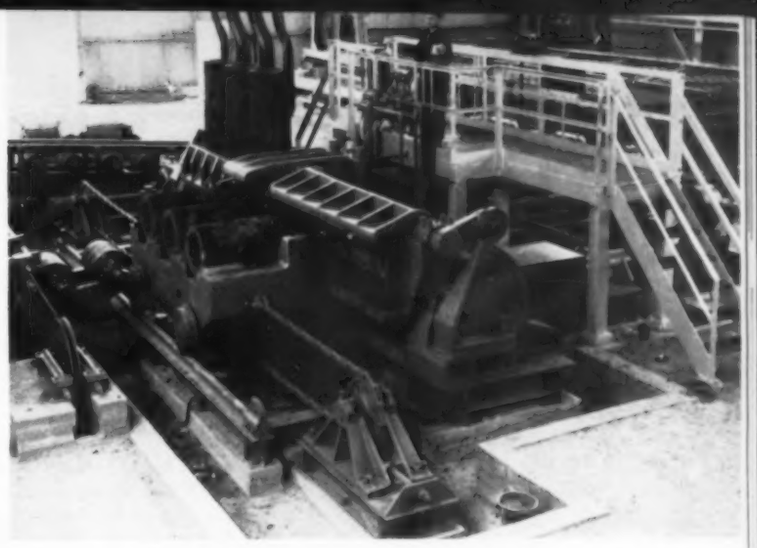


Figure 6 — The horizontal stripper is particularly adapted to production operations.

(see Figure 5). This allows them to also strip big-end-up ingots with hot tops.

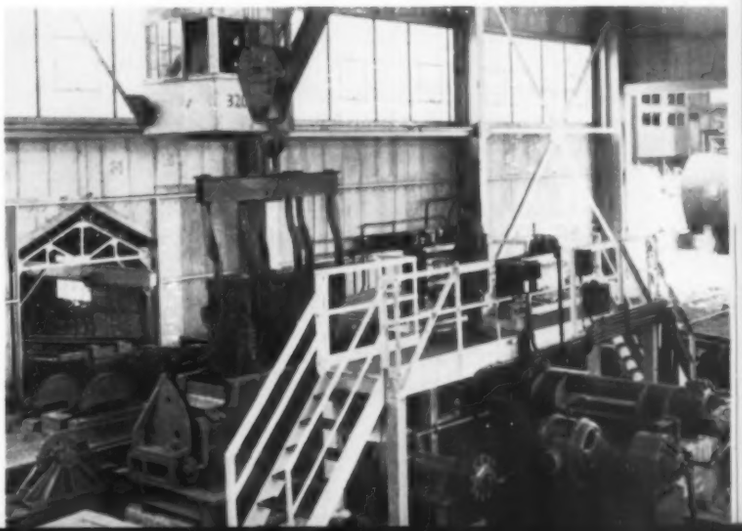
The general design of this unit consists of a slide frame, tongs, levers, and holding-down links, all of which are readily attached to the ram upon removal of the "bull-nose." This mechanism is actuated by means of the stripping screw. Instead of driving the screw in the downward position, as is done in pushing out the standard ingots, the screw is reversed, causing the tongs to grip the top of the ingots, and pull them from the mold.

The unit can be attached or detached from the standard stripper in from five to fifteen minutes. Included with the unit is a chair which provides a satisfactory means of supporting the mechanism when not in use. This same chair also supports the "bull-nose" when the pull tongs are used.

Horizontal hydraulic ingot stripper—Stripping ingots from molds on a productive basis can be done very well by means of a horizontal hydraulic stripper together with a tilting device. (see Figures 6 and 7).

This type of stripping arrangement requires an overhead electric crane equipped with a lifting beam having three pairs of hooks engaging trunnions on the

Figure 7 — This unit handles three molds at one time.



molds. The molds are conveyed from the pouring platform to the tilter. The tilter places the molds in a horizontal position on the car.

The car is then moved to a position in front of the stripping mechanism at which time the stripping cylinders are energized and the ingots are pushed from the molds with a large diameter hydraulic cylinder having a stroke of about 18 in. A small diameter cylinder will then continue the pressure in a forward direction until the ingot is completely stripped from the mold. The ingots drop to a conveyor one at a time and are carried to a reheating furnace. The car with the empty molds proceeds to a position beside a second tilter which elevates the molds from a horizontal position to a vertical one where the crane with the multiple hooks removes them to the pouring platform.

DISCUSSION

PRESENTED BY

J. A. BELL, Chief Engineer, Bethlehem Plant, Bethlehem Steel Co., Bethlehem, Pa.

R. J. HARRY, Vice President, Alliance Machine Co., Alliance, Ohio

H. W. BALL, Assistant Chief Engineer, The Morgan Engineering Co., Alliance, Ohio

J. A. Bell: The main points covered in the paper pertain primarily to the features involved in the particular design of extracting equipment as manufactured by the author's company, and since past experience has proven this equipment to be quite successful in performing the functions for which intended, there is very little room for criticism or comment.

However, there is one point worth giving some serious thought and that is the matter of capacity. In our own plant at Bethlehem, the largest stripper cranes are rated at 200-ton capacity. According to Mr. Ball, these cranes can exert a force of up to 800 tons.

While this may appear to be quite excessive from the standpoint of ingot extraction, we have found that even this is not enough to handle some of our stickers. Having designed and built a portable extracting unit for our own use, we are quite certain that a stripping mechanism to handle all grades of ingot stickers calls for an independent unit capable of exerting a force of at least 1500 tons.

Since this is evidently more than a stripping crane can reasonably be designed for, my question would be, "Has any thought been given to the design of a suitable and separate unit capable of handling this capacity?"

In reference to this high capacity, one of the main objections to a unit hydraulically operated is the diameter of ram permissible without making any change to the size of the plug hole in the bottom of the big-end-up ingot molds. The maximum diameter ram under such high pressures, would pierce the ingot. A change to recommended larger diameter would mean change to all molds on hand and all future molds would have to be provided with the larger core.

This separate unit referred to might be located off to one side of the stripper building, between the outer track and the building wall and located in a position to where the ingot and mold could be transferred from the ingot buggy and placed in the stripping unit by the same stripper crane. This would eliminate the transfer of the sticker from the stripper building to another location outside the confines of the stripper building, to say nothing of the time lost in handling by an additional crane.

While present stripper buildings in most instances would not be adaptable for this installation without the removal of one or more ingot tracks, a two or three bay extension with switch-over might be the answer. However I realize this is almost out of the question in most of our stripper buildings, requiring the unit be located elsewhere.

It is our opinion that this extra capacity should be given serious consideration in the future design of extracting equipment.

R. J. Harry: The push pull stripper which is now the type of stripper universally employed for stripping ingots has been developed to such a point that its dependability is well established.

We have found in recent negotiations that strippers of larger capacities are being considered and whereas the standard rating which has been established over the years has been 200-ton rated capacity, with an overload capacity of 600 to 800 tons,some of our latest stripper inquiries call for a rated capacity of 400 tons and an overload capacity of 1000 to 1200 tons stripping forces. Strippers of more than 300-ton rated capacity have been operating for years.

These capacities and the figures given by Mr. Ball on tests made on screw strippers should prove conclusively that it is not necessary to enter the field of hydraulics to obtain the desired stripping force for removing ingots from the molds.

Mr. Ball has also pointed out that it is not necessary to raise the mold and ingot from ingot car in order to perform the stripping operation. It appears that many operators do not realize the stripping force is exerted between the mold and the ingot, and that when the ingot is being removed from the mold and the mold is resting on the car, the stripping force is not transmitted to the car.

In the 1947 Proceedings of the Association of Iron and Steel Engineers, p. 177, I discussed the use of an electric counterweight which makes it impossible to strip an ingot when the mold is not resting on the ingot car. This system of electric counterweighting has been installed and is working most successfully on a 250-ton normal rating stripper and effectively prevents injury to the ingot cars, which happens when ingots are dropped by careless operators.

The life of a push pull stripper, especially that of the vital screw mechanism, is dependent on lubrication and too much emphasis cannot be given to this feature.

Mr. Ball has described an ingot that is hard to remove as a "sticker." I think it would be more proper to state that an ingot that cannot be removed from the mold by the conventional stripper is a "sticker." Steel mill operators are trying to get the maximum mold life

possible, but still find it necessary to send many "stickers" to the scrap drop to have the molds broken off. It was to save as many as possible of these molds, that we developed the impact stripper.

An impact stripper with a properly proportioned inertia (or anvil) block can exert a force of 4000 to 5000 tons in removing a 10 to 15-ton ingot from the mold when the ingot and mold are dropped the desired distance.

This impact stripper is capable of stripping large-end-up ingots with or without hot tops, small end-up ingots with or without hot tops, and since no plunger or "bull-nose" is used, the big-end-up ingot molds have a solid bottom and the usual hole provided in the bottom of the mold is eliminated.

Real "stickers" that would normally be sent to the scrap drop to have the mold broken off are easily removed by the impact stripper, and where the impact stripper is used, a fall of three to four feet is usually sufficient to strip the most stubborn sticker. The molds are not destroyed in this operation but can be used over and over again.

In a recent installation, where it was originally intended to install a standard stripper in a separate building and one soaking pit crane to handle the ingots in and out of the soaking pits to the mill, it was finally decided to increase the length of the soaking pit building a couple of bays, install the relatively inexpensive impact stripper in the soaking pit building and purchase two soaking pit cranes. This change of plan not only saved thousands of dollars but provided greater security in handling the ingots as the pit due to the availability of two soaking pit cranes and assured the minimum mold cost and elimination of real "stickers."

BLAST FURNACE BRICK DISINTEGRATION TEST EQUIPMENT*

By J. A. SHEA

Gary Steel Works

Carnegie-Illinois Steel Corp.

▲ SEMI-AUTOMATIC equipment for making disintegration tests on blast furnace lining bricks has been designed, and a suitable testing procedure developed as a result of investigations at the Gary Steel Works of Carnegie-Illinois Steel Corp. Essentially, the equipment consists of a gas-tight chamber to hold the test specimens, a suitable furnace for heating the chamber, a pump for circulating carbon-monoxide gas over the specimens in a closed system, absorption tubes in the system to remove carbon dioxide and moisture from the circulating gas, and a flow meter and pressure gage.

In making a disintegration test, the brick specimens in the test chamber are heated to 950 F in the furnace and then exposed to the action of a 20 cfhr flow of carbon monoxide gas for a period of 40 hours. Operation of the equipment during a test is semi-automatic. Forty hours of testing in this equipment was found to be much more effective than 120 hours of testing in earlier equipment.

The initial investigation at Gary of the phenomenon of disintegration of blast furnace linings by deposition of carbon in the "pores" of the brick was started in 1920. During this early work, testing equipment was designed and a test procedure was developed for determining the susceptibility of blast furnace brick to carbon-monoxide disintegration.

The test consisted of exposing samples of blast furnace bricks to the action of a flow of altered blast furnace gas for a period of 120 hours at a temperature of 840 to 870 F. The blast furnace gas was altered by passing it through hot charcoal to convert the carbon dioxide to carbon monoxide. The test chamber and charcoal tube were heated by manually controlled gas burners. Five to six weeks were required for testing 100 samples.

As a result of the early investigations, at Gary and elsewhere, brick manufacturers were able to make much improvement in blast furnace bricks, chiefly through improved firing practices. With the improved bricks, only a small percentage of those being tested could be spalled, cracked, or disintegrated by the 120-hour disintegration test. However, examination of used linings during removal from blast furnaces showed that disintegration still occurred. Zones of disintegration could be found in the linings at the end of the campaigns.

Since disintegration still occurred in the furnaces, even though most of the brick samples were not affected by the 120-hour disintegration test, it was apparent that a better disintegration test was needed. Investigations were started in 1942 that resulted in the development of the new method.

In recent years, a number of brick manufacturers have started production of hard-burned or reburned high-heat duty and super-duty bricks. These bricks are made in the same manner as the regular bricks except that they are reburned or initially fired to a higher temperature in the kilns.

Eight different brands of the harder-burned bricks have been tested for disintegration in the new equipment. Six of the eight brands passed 40-hour tests without visible indications of structural damage. A small percentage of the other two brands was superficially spalled.

Two-hundred hour tests on these same eight brands of hard-burned bricks in the new equipment, however, indicated some differences in susceptibility to damage by carbon deposition. Thus, it appears that another cycle has been completed and a better test will be required to ascertain possible differences in the disintegrating characteristics of hard-burned bricks of various brands.

*Condensation of a paper presented at the March 4, 1949 meeting of the Chicago District Blast Furnace and Coke Oven Association in Chicago, Ill.

CARNEGIE-ILLINOIS STEEL CORP. MODERNIZES COLD-REDUCTION FACILITIES AT GARY

▲ Capacity for production of cold-reduced tin plate and sheet steel has been increased at the Gary Sheet and Tin Mill of Carnegie-Illinois Steel Corp., by extensive additions of new equipment and revision and replacement of existing facilities.

Completion of the program will augment plant capacity by increasing yields, by increasing operating speeds, and by providing more efficient handling methods.

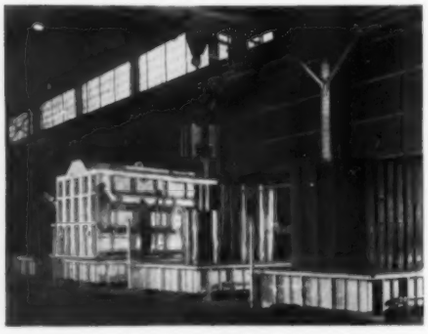
Yields will be increased by adopting the use of much heavier coils for processing than used formerly. These heavier coils are obtained by welding smaller coils end to end to form the long, continuous lengths required for the larger units. Thus, continuity of the rolling and other processes is improved by eliminating more frequent starts and stops for changing lighter coils of shorter lengths.

Product quality of both sheets and tin plate has been improved, due to features providing closer process control at all steps of their manufacturing. Notable changes that resulted in production of better tin plate included equipping the annealing department with new annealing atmosphere processing units, and installation of alkaline cleaners on the three existing electrolytic tinning lines.

Major installations of new equipment were for production of sheets, and comprised: a 54-in., four-stand, cold-reduction mill; a 60-in., high-speed temper mill; a 54-in. electrolytic-cleaning line; a 54-in. side trimming and slitting line; a 54-in. shear line for cold-reduced and another for hot-rolled products; 16 coil-annealing furnaces with 56 bases; and two 76-in. scrubbing and drying lines. Various changes and additions were made to the 80-in. continuous hot mill and 84-in., three-stand, tandem cold-reduction mill to increase their capacities. New additions to continuous coating facilities include a galvanizing line and a terne-coating line.

Figure 2 — The new 54 in. four-stand-tandem cold-reduction mill operates at speeds up to 3000 fpm.

Figure 1 — View of part of the new annealing equipment for tin-mill products installed in the Gary Sheet and Tin Mill of Carnegie-Illinois Steel Corp.



IMPROVEMENTS AT 80-INCH HOT MILL

Modernization and improvement of the 80-in. continuous hot mill to increase the plant's over-all capacity for production of cold-reduced sheet steel and tin plate included installation of two additional slab-heating furnaces. Improvements to the three existing slab-heating furnaces increased capacities of the latter nearly 110 per cent to match the new units. Other changes to the mill included: replacement of handling equipment, vertical edgers, roughing and finishing guides; replacement of down-type coilers with new mandrel-type coilers designed to handle heavier coils; replacement of the scale-breaker; alterations to the slab squeezer and coil conveyor; replacement of the piler, coil conveyor, and center run-out table; and improvements to slab pushers. These and miscellaneous smaller changes were

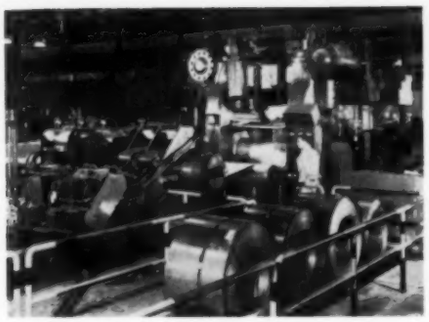


Figure 3 — In the sheet mill of Carnegie-Illinois Steel Corp.'s Gary Sheet and Tin Mill, temper rolling facilities were increased and speeded up.

made to increase plant capacity by providing 12,000-lb hot-rolled coils for tin plate and up to 20,000-lb hot-rolled coils for sheet products.

TIN PLATE PRODUCTION

Flash welders were installed on the No. 8 and No. 10 continuous pickling lines to permit the experimental welding of hot-rolled coils from the 80-in. continuous mill into 24,000 to 30,000-lb coils. The coilers on these lines were replaced and the guides altered.

Speeds of two five-stand tandem cold-reduction mills were increased from 1700 to 4600 fpm. Uncoilers, recoilers, and related parts were replaced, to permit the processing of heavier coils on these two mills, as well as on five electrolytic cleaning lines, replacing existing equipment which was too light to meet the new operating conditions. Uncoilers of the temper mills were reinforced and heavy-duty up-enders were provided to meet increased load requirements.

Six coil-annealing furnaces with 16 bases were installed to provide additional annealing capacity (Figure 1). The height of 44 existing furnaces was increased and 135 existing bases were altered to provide for the larger coils.

New shearing equipment includes five flying-shear lines for handling the large coils at higher shearing speeds (up to 1000 feet per minute).

COLD-REDUCED SHEET

Coil-storage conveyors were added at the continuous pickling lines of the sheet mill along with flash welders, and improved charging and handling facilities. Side trimmers were installed and recoilers replaced with heavy-duty units on these lines. These changes permit increased capacity by welding hot-rolled coils from the 80-in. continuous hot-mill end to end to form larger coils weighing 1000 pounds per inch of width.

Cold-reduction facilities were increased by the installation of a 54-in., four-stand, tandem cold-reduction mill that operates at 3000 fpm (Figure 2). The uncoiler and recoiler were replaced on the existing three-stand tandem mill and its speed was increased. Tensiometers, side guides, a scale and an up-ender were also installed on the latter mill.

A new continuous electrolytic-cleaning line was installed to provide capacity for cleaning cold-reduced sheet coils up to 48 inches wide.

A new 54-in. shear line for cold-reduced and another for hot-rolled products, and a new 54-in. side trimming and slitting line were added to sheet-mill shearing equipment. Improvement and relocation of several existing shearing and recoil lines were undertaken in addition to alterations to a line for heavy-gage hot-rolled products. These additions and changes were made to obtain the required capacity for processing products in both sheet and coil form.

Sixteen new coil-annealing furnaces were installed and ten were rebuilt, and a normalizing furnace was relocated. A new high-speed temper mill was installed (Figure 3) and three additional temper mills were rebuilt and relocated. In the finishing and shipping departments, two new resquaring shears, a new oiling machine and levelers were installed, and some existing equipment was relocated.

Other major items in the sheet steel production modernization program include: new high and low-voltage power distribution systems, feeder lines; water, gas, air and sewer lines; as well as additional railroad and transfer tracks and handling facilities.

INDUSTRIAL TRUCK BATTERY CHARGING

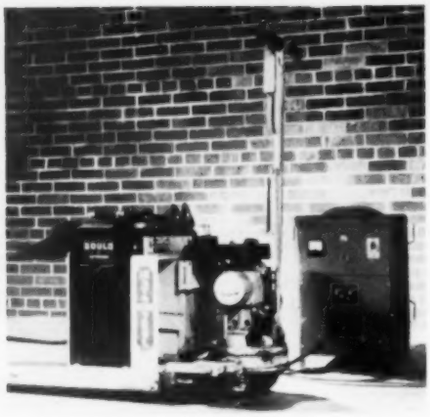
By K. A. VAUGHAN
Manager Field Engineering
Gould Storage Battery Corp.
Trenton, N. J.

▲ The most important phase of storage battery care is charging. Undercharging can result in insufficient battery capacity to meet the duty schedule. Overcharging causes the battery to gas and overheat and has harmful effects on the plates.

Battery charging replaces energy taken from the battery during its duty cycle. When a storage battery is discharging, sulphuric acid (or the electrolyte) reacts with (a) the lead peroxide of the positive plates, and (b) the sponge lead of the negative plates. During this reaction electrons are set in motion and an electric current results. As the reaction progresses, lead sulphate forms on both negative and positive plates and the electrolyte becomes weaker and weaker until finally no further action takes place and no more energy is available to be converted into useful work. In order to restore the positive and negative plates to their former composition, and to return the electrolyte to its former strength, or specific gravity, energy is supplied to the battery. This is accomplished by "charging" the battery with direct current which reverses the above reaction. Direct current only must be used to keep this reaction in the "reverse" direction.

When the lead sulphate has been reconverted to lead peroxide (positive plate) and sponge lead (negative plate), and the electrolyte restored to a fully charged condition (normally a specific gravity of 1.280), the battery is fully charged and is storing energy.

In modern manufacturing processes the industrial truck must be in operation during the entire shift or



"On the spot" charge stations eliminate delays in transporting batteries to central charge stations.

else the integration of material flow is interrupted and work delays and stoppages result. It is therefore necessary to charge the battery when the truck is not being used. This leads to the selection of batteries having adequate capacity to supply power for full shift operation.

In general, truck batteries are put on charge at the end of the shift and charged for an eight hour period. They are then ready for the next duty cycle. For two and three shift operations, extra batteries are employed.

Occasionally, it becomes necessary to charge the battery at other times. For example, a "boost charge"—a charge given at a high rate and for a short period of time—is sometimes required when the truck is used to perform more work than normal. This extra work draws extra current from the battery and necessitates an "emergency" charge. The boost charge is given during a lull in the work cycle (say during lunch) and is not recommended as an everyday practice but rather as an emergency measure.

In plants where there are large fleets of trucks operating more than one shift, it is advantageous to schedule the changing of batteries to prevent a backlog from developing at the charging room. By assigning each truck a specific time to report to the charging room, each truck will be out of operation for the shortest possible time.

The battery can be brought to a central charging station for charging or it can be charged by a small charger in the particular department in which it operates. In large plants where the central station may be situated some distance from outlying departments, considerable time can be saved in transporting batteries to and from the station by the installation of small "on the spot" charge stations located in the various departments.

For maximum battery life and efficiency it is advisable that a man trained in battery technology be in complete control of battery charging. He should be made responsible for the care of the battery and be required to keep records on each battery. In this connection, the central charging station is more advantageous than spot charging. In central charging, one man can control all charging operations, whereas in "on the spot" charging the truck operator puts his equipment on charge, and depending on the operator, the battery receives good, bad or indifferent treatment.

In general, there are two methods of charging batteries—the "modified constant voltage" method and the "two-rate" method.

When charging current is supplied by the MCV method, the charging current automatically tapers off as the battery becomes charged due to the increase in the counter voltage of the battery as it becomes charged. Automatic equipment shuts off the charging equipment when the charge is complete.

The two-rate method of charge, as the name implies, charges the battery at two rates. Current is supplied at a high rate during the first part and greater length of the charge, and at a low rate for the remaining duration of the charge. The change from the high rate to the low or finish rate occurs at the gassing point of the battery, which is when the battery is approximately 80 per cent charged or individual cell voltage reaches 2.37 volts at 77 F.

A motor-generator or rectifier is generally used for charging purposes. With the motor-generator, either MCV or two-rate charging can be employed, although the MCV method is usually used. Present-day rectifiers charge by the two-rate method.

The manufacturers of charging equipment will provide the correct charging equipment if given the number, size, and types of batteries to be charged. Charging equipment can be purchased which is capable of charging large or small, many or few, batteries.

The two methods most frequently employed to control the charge to the battery involve: (1) the ampere-

The battery can be transported to a central charging station for charging. Through proper scheduling backlogs will not develop.'

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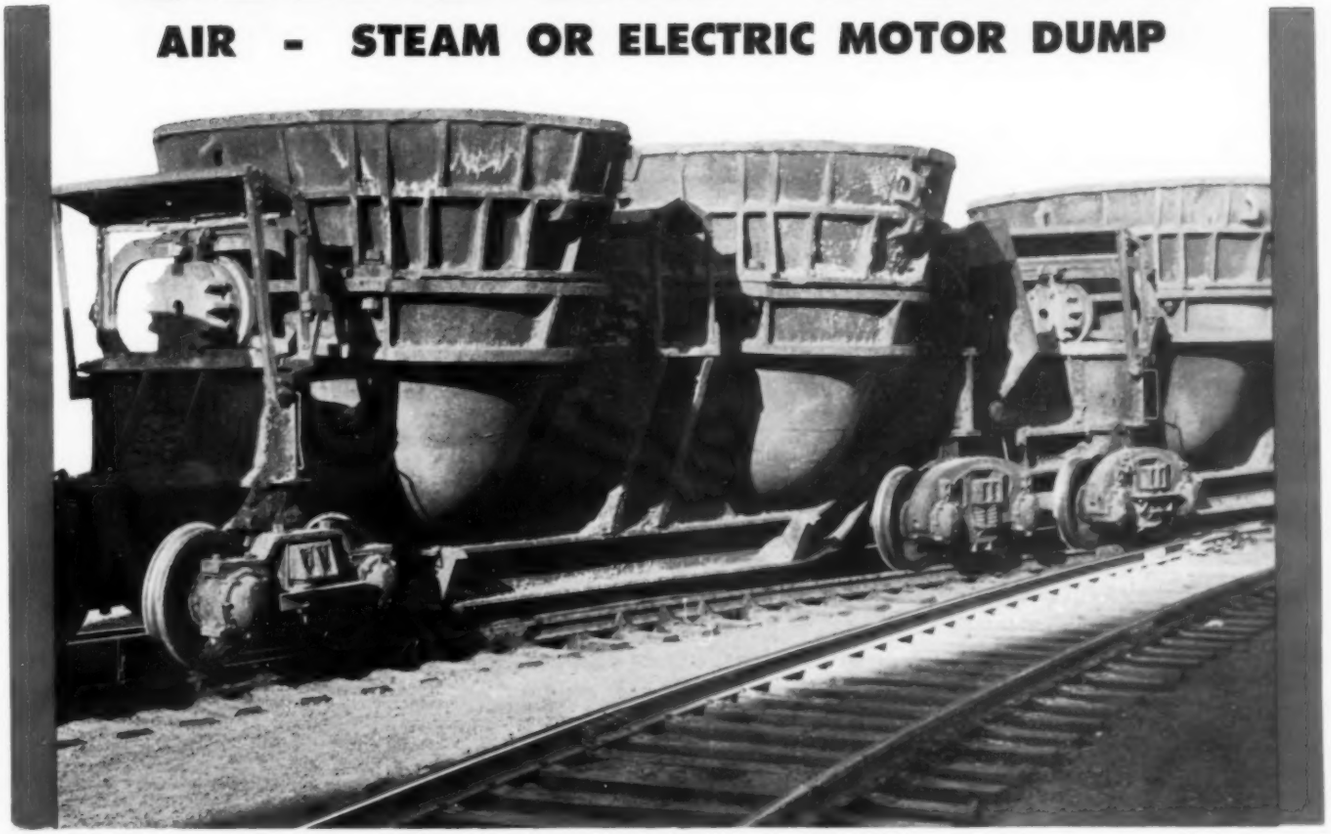

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hour meter, and (2) the voltage relay timer.

When the ampere-hour meter is used, it is necessary to set the ampere-hour meter on the panel of the charger before starting the charge. This is necessary to be sure the battery receives the correct ampere-hour charge depending upon the extent to which it has been discharged. In setting the ampere-hour meter the specific gravity of a pilot cell of the battery is taken and an ampere-hour meter chart, supplied by the battery manufacturer, is consulted to obtain the correct meter setting. Once the meter is set and the battery is connected, no further adjustments need be made. When the ampere-hour meter is used in two-rate charging, additional resistance is automatically cut-in to the circuit when the battery reaches 80 per cent charge. This lowers the charge rate from the high rate to the recommended finish rate. When the battery is fully charged a quick-break contact terminates the charge.

Ampere-hour meters are available which can be mounted on the truck body and can be connected to the circuit so that they register both the discharge and recharge and do not have to be set for each recharge. These meters have the disadvantage of being subjected to damage during truck operations and this damage in many cases causes inaccuracies.

When the voltage relay timer is used, it is only necessary to connect the battery to the charging equipment and the charge rates are then automatically controlled. When used with MCV method of charge the voltage relay operates at 2.37 volts per cell at 77 F which starts a timing device which in turn terminates the charge after a predetermined time. (Usually 2½ to 3½ hours). With the two-rate method the voltage relay not only starts the timer but also reduces the charge rate from the high to the finish rate.

Charging equipment is set at the correct voltage for the size battery used in the plant and is seldom changed. However, voltage and charge rates should be checked periodically and for this reason charging equipment, volt meters and ammeters should be checked at least once a year. The charging equipment voltage setting will depend upon the number of cells in the battery. A value of 2.63 volts per cell has been determined by the characteristics of the lead acid battery and by agreement within the battery industry as that most satisfactory for charging industrial truck batteries when using the MCV method of charge. Thus, an 18 cell battery would require a setting of 2.63 x 18 or 47.34 volts.

The resistor governing the flow of current to the battery being charged also remains fixed and requires no adjusting. The current required depends on the capacity of the battery as expressed in ampere-hours. The starting rate of charging a discharged battery can be from 15 to 22.5 amperes per 100 ampere-hours capacity. Thus, a 500 ampere-hour battery would require 75 to 112.5 amperes starting rate. The finish or low rate of a battery should be 5 amperes or lower per 100 ampere hours capacity, thus a 500 ampere-hour battery would finish at 25 amperes or lower.

The MCV method of charging is generally used because it is simpler and is slightly cheaper than the two-rate method. It is recommended for use where the voltage relay timer is used to control the charge because occasionally the voltage relay timer does not work and if two-rate charging was used in conjunction with this voltage relay timer, the battery would be charged continuously at a high rate resulting in overheating, gasing, loss of electrolyte and if repeated often, serious damage to the plates.

The two-rate method is always used when the bus voltage is greater than 2.63 volts per cell.

In all charging operations it is highly recommended that records be kept on each battery. Such data as the battery number, the truck from which it was taken, the specific gravity of a pilot cell when put on charge, time put on charge, ampere-hour meter setting, time taken off charge, specific gravity of pilot cell after charge, and the truck to which the battery is assigned, should be carefully kept. This data not only gives a case history of the battery and indicates approaching old age and battery damage but it also keeps the charging room attendant more alert in performing his duties.

Before leaving the subject of battery charging, the "equalizing" charge should be mentioned. An "equalizing charge" is an additional charge of three or four hours at the finishing rate of the battery. Its purpose is to be sure all cells are brought up to a fully charged condition. It should be given at least once a month and not more than once a week, depending on the duty cycle. Voltage and specific gravity readings should be recorded at the finish of each equalizing charge as an accurate record of the condition of the battery.

BATTERY RECORD

Day Operator _____ Night Operator _____ Date _____

Battery Number	Charging										Put in Service			Returned			Remarks:
	Started					Finished											
	Date	Time	Amps	Temp	S.G.	Date	Time	Amps	Temp	S.G.	Date	Time	Truck No.	Date	Time	S.G.	

It is recommended that records be kept on each battery so that a case history is available.

HEATING OF MILL BUILDINGS

By CHARLES P. CRYER
Field Engineer
Machinery Division
Dravo Corp.

▲ High ceilings and expansive areas of undivided floor space make mill-type structures hard to heat. Maintaining comfortable temperatures for personnel in such buildings is a problem because large volumes of warm air rise to the upper stratum out of the "working zone." Moreover, loss of heat to the roof usually results in excessive fuel consumption.

During the past winter, however, the problem was solved at a large steel plant by using six direct-fired space heaters that operate on the principle of warm air recirculation in the working zone. In effect, the heaters create a comfortable "blanket" of warm air in the space from the floor to about 12 ft above the floor. The heating equipment is fired economically with a mixture of coke oven and blast furnace gas.

The building heated by these six heaters is a standard mill structure 876 ft long by 105 ft wide. There are no partition walls dividing the floor area. Height to the bottom chord of the truss is 55 ft and there is an additional 46 ft to the peak of the monitor roof. Both sides of the monitor have top hung continuous sash windows 6 ft high. Each side wall also has continuous 6 ft windows its entire length. Walls are of brick and metal siding. Each of the 30 bays has a Stevens roof ventilator.

On the basis of standard methods of calculation, heat losses for this large structure were figured at approximately 21,500,000 Btu per hour with a 40 F temperature rise and with three air changes in the northern third of the building and one air change in the other two-thirds.

Figure 1 — This steel mill building presented a difficult heating problem because of its tremendous size. Six heaters, operating on the principle of warm air recirculation in the working zone of the building, now maintain satisfactory temperatures. Sixteen steam unit heaters previously installed in the trusses could not hold enough heat for comfort at floor level.

The steel company previously sought to solve the heating problem in this building, which was built about two years ago, by using 16 steam unit heaters mounted in the trusses and discharging downward. These units were ineffective because they did not carry sufficient warm air into the working zone. Company engineers then decided to replace the 16 unit heaters with six floor-mounted Dravo Counterflo heaters.

Despite the large calculated heat loss, it was determined that the six heaters, each with an output of 2,000,000 Btu per hour, could maintain satisfactory temperatures in the structure because of their "heat blanket" principle of operation. These self-contained heaters draw air from floor level, warm it and then discharge it through overhead directional nozzles 12 ft above the floor. Each heater handles approximately 22,000 cfm of air and discharges through nozzles at a velocity of approximately 2000 fpm. Thus, large areas can be covered without blowing heated air directly on personnel or using ductwork. The recirculation method also tends to keep warm air from rising rapidly to the roof. Air from the floor is drawn to the large intake grilles in the heater base in large quantities but at relatively low velocity, thereby minimizing drafts. A 20 hp motor in the base of each heater powers the double-width centrifugal fans which draw in the air and force it over the stainless steel combustion chamber.

Although temperatures along the eastern seaboard, where the plant is located, have not been low this season, experience so far with this heating system indicates it will provide satisfactory comfort during normal winter weather in the region which is in a 0 F design zone.

The six heaters are located so as to provide a warm air blanket for the

Figure 2 — One of the six Dravo heaters that are used in the steel mill structure is shown left near the shear machine for cold sheet steel. Air drawn from the floor into the base of the heater is warmed and discharged at a velocity of 2000 fpm through nozzles 12 ft above the floor. This method establishes a warm air blanket for the working area, keeps down heat losses through the roof 96 ft above the floor.

entire working area. Four are spaced about 195 ft apart along the west wall, discharging toward the east wall. One is positioned in the center of the north wall and one is in the center of the south wall.

Operations in the building include cold rolling of sheet; skin passing, tempering, shearing, scrap baling and roll grinding and storage. There are three cranes operating 40 ft above the floor. Two are 40-ton capacity and one is a 75-ton crane. Production consists of general sheet used for automobiles, refrigerators and similar products.

Use of the mixture of coke oven and blast furnace gas to fire the heaters necessitated installation of stainless steel main and pilot valves to resist the corrosive effects of the sulphurous fuel. Special access plates were fabricated for the exhaust fan scroll for easy cleaning. The fan motor in the heater base was totally enclosed to keep out dust and dirt. The motor and shaft bearings are in the path of the intake air stream and so are kept cool during operation.

The gas mixture used is supplied at a pressure of 10 psi and is rated at about 500 Btu per cu ft. It contains about 450 grains of hydrogen sulphide (H_2S) per 100 cu ft. The analysis of this gas showed the following properties:

Carbon dioxide (CO_2)	2.9 per cent
Oxygen (O_2)	0.6 per cent
Cyclo-propane (C_3H_6)	2.8 per cent
Carbon monoxide (CO)	8.1 per cent
Methane (CH_4)	26.8 per cent
Hydrogen (H_2)	47.2 per cent
Nitrogen (N_2)	11.6 per cent

The stainless steel combustion chamber, standard in all Dravo heaters, resists corrosive attacks of this gas and its combustion products. Moreover, the chamber does not require refractory lining and permits more rapid transfer of heat from flame to air.

To achieve maximum utilization of the heat produced within the combustion chamber, the hot gases are moved to the exhaust stack through two staggered banks of "economizer tubes" that intersect the air stream flowing in through the heater base. These tubes have inside swirlers that force the gases to wipe the tube walls which provides transfer of their heat value to the air.

Besides their use for space heating during cold weather, the heaters can be employed during the summer months for ventilating by operating their fans.

Simplicity of installation was another factor taken into consideration by the steel company's engineers who worked on this project. The heaters needed only a power line, fuel piping and vent stack to be installed. They are mounted directly on the wood block floor of the mill building.

In addition to these six heaters, the same company uses three smaller ones (1,000,000 Btu output capacity) to maintain a uniform temperature of 70 F in a new structure housing the steel mill's oxygen generating equipment. In this building, 100 ft long by 40 ft wide by 20 ft high, some 7,000,000 cu ft of oxygen are generated monthly. Built of aluminum siding on a steel frame, the structure must be kept warm to prevent freezing of caustic soda in eight 38-gallon tanks that are located along one wall. The heaters in this building are equipped with special motors, controls and relays because the power supply enters at 550 volts, 25 cycles.

CLEVELAND DISTRICT SECTION, ASSOCIATION OF IRON AND STEEL ENGINEERS

MAY 23, 1949

2:00 p. m.: Inspection trip through new stainless steel facilities of the Republic Steel Corp., Massillon, Ohio.

6:00 p. m.: Dinner.

8:00 p. m.: Meeting—"Developments and Use of Stainless Steel," by V. W. Whitmer, Assistant Metallurgist, Central District, Republic Steel Corp., Massillon, Ohio.

Reservations must be made through: Mr. W. W. Spanagel, Secretary Cleveland District Section AISE, 1200 Ivanhoe Road, Cleveland, Ohio.

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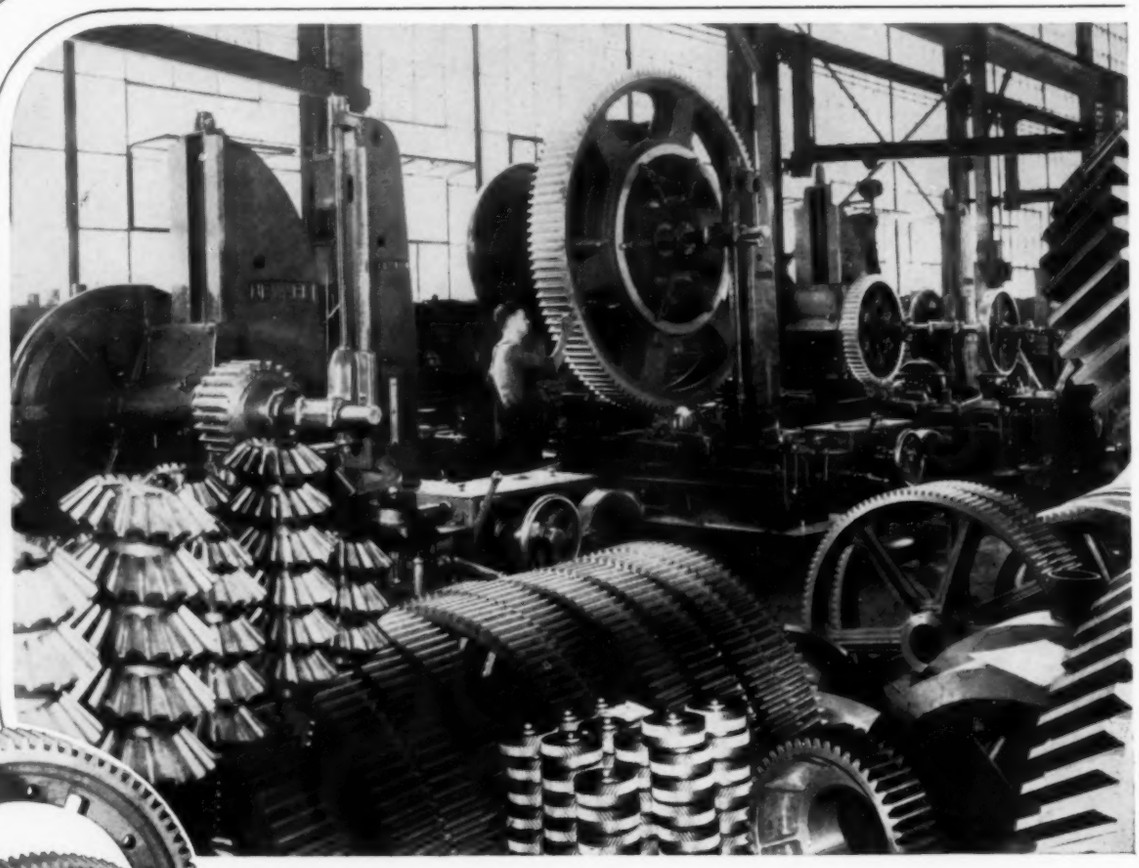

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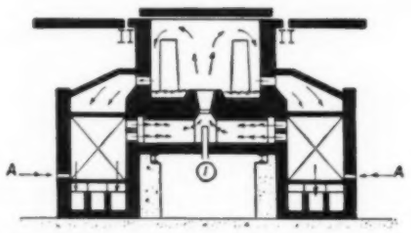

AMCO Vertically Fired Soaking Pit

SYMBOLS

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Amco Recuperator
Waste Gas
Cold Air
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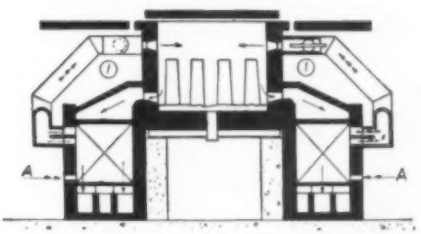

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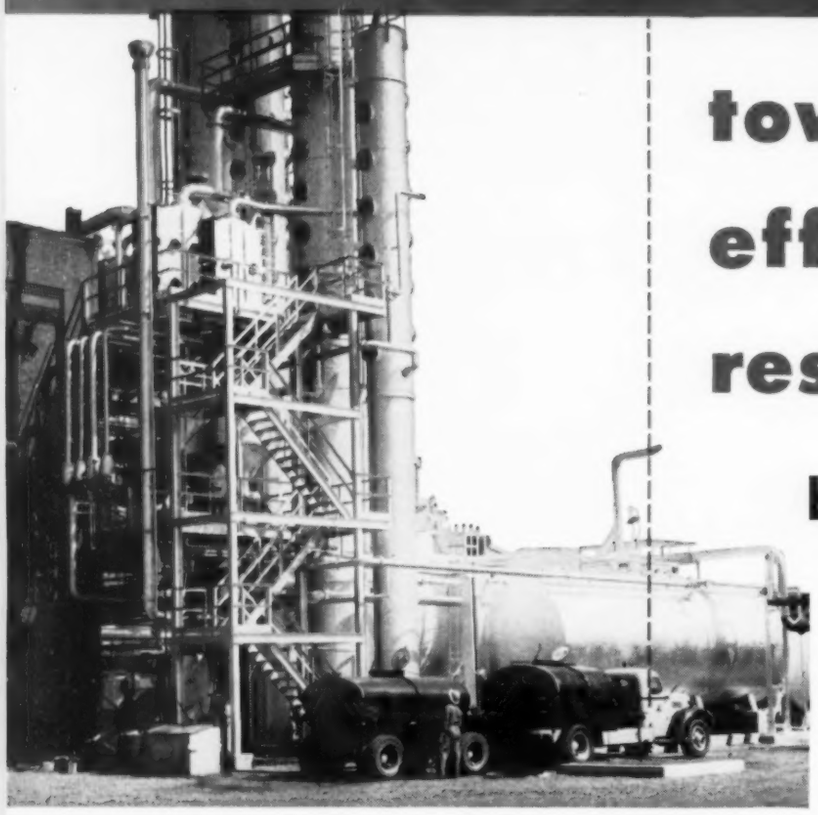

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A SERVICE ORGANIZATION

Date-line Diary...

March 2

▲ The Granite City Steel Co. cut prices of cold rolled steel sheets by $10.00 for a new figure of $84.00 a ton.

▲ United Engineering and Foundry Co. shut down its steel making facilities at New Castle, Pa. where they had been producing 4500 tons of steel monthly for the Westinghouse Electric Corp.

▲ The Interstate Commerce Commission estimated that rail, freight and passenger traffic for 1949 will be 8.2 and 11.4 per cent respectively below the figures for 1948. The estimate was made in support of the railroad's increase for a permanent 13 per cent increase in freight rates.

March 3

▲ In 1948 the Bethlehem Steel Co.'s Shipbuilding division completed and delivered 59 ships compared with 22 in 1947.

March 4

▲ The Census Bureau announced that unemployment in February hit a new peak of 3,221,000 although the 57,168,000 persons employed topped all previous Februaries.

March 5

▲ In a report submitted to the Polish Parliament, it was stated, that construction of new steel plants will eventually triple present annual production of 1,500,000 tons of steel. Two new mills will be built in lower Silesia.

March 6

▲ New construction put in place in February was 9 per cent below January 1949 but 14 per cent above January 1948.

March 7

▲ Based on reports from companies having 94 per cent of the capacity of the industry, the operating rate of the steel industry is scheduled to be 101.4 per cent of capacity for the week beginning March 7, 1949. This is equivalent to 1,869,300 tons of steel ingots and castings compared with 1,852,700 tons one week ago.

▲ Effective today the Federal Reserve Board relaxed a number of its installment credit curbs.

March 8

▲ In Birmingham No. 1 steel scrap dropped $4.00 a ton to $29.00.

▲ The British Iron and Steel Federation announced that production of steel in February was at an annual rate of 16,176,000 tons which breaks all previous records.

▲ The Anaconda Copper Mining Co. has put in production the second of a series of electric furnaces, which will be used to produce ferro-manganese. An additional three furnaces are under construction at this plant which is at Anaconda.

March 9

▲ Effective today the Sloss-Sheffield Steel and Iron Co. increased its price for ferro-manganese to $174.00 per gross ton for a raise of $12.00 a ton. The Bethlehem Steel Co. also raised its price $12.00 a ton.

▲ Effective April 1 the Pittsburgh Consolidation Coal Co. announced it will cut the price of soft coal in the Northern West Virginia field from 15 to 40 cents a ton.

▲ Lead prices were cut 2 cents a lb to a figure of 19½ cents a lb in New York. This is the first break in major non-ferrous metal prices.

▲ The Bureau of Statistics of the Dominion of Canada reported that steel production in January totaled 284,707 tons which is the highest since May, 1948.

March 10

▲ According to Business Week it is estimated that the total number of homes to be built in 1949 are estimated at 875,000 compared with 925,000 units started in 1948.

March 11

▲ The General Electric Co. reported that net sales in 1948 were up 23 per cent to a new high figure of $1,632,700,806. This is equivalent to $4.29 a share compared with $3.30 in 1947.

▲ The American Iron and Steel Institute reported that the January payroll for the industry was estimated at $202,057,000. Employment set a post war record of 650,000 during the month and average earnings were $1.713. Workers averaged 39 hours a week in January compared with 40 in December.

March 12

▲ Senator Ellender of Louisiana predicted that Congress will not authorize government construction of steel producing facilities.

March 14

▲ John L. Lewis called out his workers for a two week period to protest the appointment of James Boyd as director of the Bureau of Mines, and as a memorial to miners killed or injured last year.

▲ Pittsburgh Coke and Chemical Co. have made an agreement with the General Motors Corp. to supply substantial tonnages of coke and pig iron for a five year period. Materials will start moving under this agreement next September. To meet these requirements a battery of 35 coke ovens are being added to the facilities on Neville Island.

▲ Based on reports from companies having 94 per cent of the capacity of the industry the operating rate of the steel industry is scheduled to be 102.0 per cent of capacity for the week beginning March 14, 1949. This is equivalent to 1,880,400 tons of steel ingots and castings compared with 1,869,300 tons one week ago.

March 15

▲ The United Engineering and Foundry Co. reported today record earnings for 1948. Net sales are $52,473,267 and net income was $5,045,972 or $6.08 a common share after preferred dividends.

▲ American Smelting and Refining Co. cut the price of lead for the second time this week with an additional decrease of 1½ cents a lb which gives a new figure of 18 cents a lb.

▲ Department of Commerce removed its curbs on the amount of tin which can be used in making beer and animal food cans. Other type cans will continue on the present formula which limits tin consumption to 50 per cent of the amount used in the 1947 period.

▲ Republic Steel Corp. purchased a stock interest in the Liberia Mining Co., Ltd. an iron ore mining company in Liberia, West Africa. This development has ore containing 68 per cent Fe. Development so far has been limited and a 45 mile railroad must be constructed to Port of Monrovia and terminal handling facilities will also be required. Republic Steel Corp. expects that the ore can be delivered to its properties to its advantage and the surplus will be marketed to other companies. It is estimated that reserves will run from 5,000,000 to 14,000,000 tons of high grade ore and 75,000,000 to 150,000,000 tons of milling grade ore. The ore is a mixture of hematite and magnetite and is available at ground level.

▲ Effective March 15, the Pittsburgh Coal Co. closed down its Midland, Pa. mine because of lack of demand for coal.

March 16

▲ The International Bank for reconstruction and development has granted a $16,000,000 loan to Belgium to finance equipment required in the construction of two steel plants and a power plant near Liege.

▲ Reserve Mining Co. started operations at its new pilot plant at Ashland, Ky. for pelletizing iron ore concentrates. If tests are found successful a full scale $100,000,000 taconite, concentrating and pelletizing plant will be built at Beaver Bay on Lake Superior.

▲ United States Steel Corp. announced that production in 1948 was 29,300,000 tons of ingots and castings or 93.8 per cent of capacity. Shipments of steel products were 20,700,000 tons. The corporation mined 48,900,000 tons of ore during the year and about 3,000,000 tons of this were derived from low grade ores.

▲ The Jones & Laughlin Steel Corp. reported new records for sales and earnings in 1948. Sales were $446,057,000. The net income was $31,222,000 or $12.01 per common share.

March 17

▲ A Shipper's Advisory Board for the Great Lake Region predicted that ore shipments on the Great Lakes in 1949 will be 83,000,000 tons.

▲ Effective today the Carnegie-Illinois Steel Corp. raised the price of ferro-manganese $12.00 a ton to $175.00 a gross ton.

▲ Department of Commerce reports that the United States is in a better position for its tin supply because tin imports in 1948 were 86,323 gross tons compared with 64,192 gross tons the previous year. About 90,500 tons were consumed by industry in the United States last year.

March 18

▲ The Allis-Chalmers Manufacturing Co. reported a profit for 1948 of $15,441,523 equivalent to $5.67 a common share after preferred dividends. Sales billed in 1948 totaled $328,101,328.

March 19

▲ According to Ward's automotive reports production of cars and trucks in the United States and Canada was 119,674 units this week which is the highest for the year.

▲ The Sharon Steel Co. reported that they must close their blast furnace and four open hearths because of coke shortages due to the coal mine holiday. This holiday has also forced several railroads to lay off a large number of employees.

March 20

▲ The first break in motor oil was announced by the Continental Oil Co. which should result in cuts by dealers of about 5 cents a quart on premium and secondary grade oils.

March 21

▲ Based on reports from companies having 94 per cent of the steel capacity of the industry, the operating rate of steel industry is scheduled at 101.1 per cent of capacity for the week beginning March 21, 1949. This is equivalent to 1,863,800 tons of steel ingots and castings compared with 1,880,400 tons one week ago.

▲ United States Steel Corp. plants in the Pittsburgh area may be faced with a strike by its railroad employees over working rules.

March 22

▲ The Kaiser Co. announced reductions in steel prices ranging from $10.00 to $39.00 a ton at its Fontana plant.

March 23

▲ The American Institute of Steel Construction announced that total bookings of fabricated structural steel for February were 106,203 tons. February shipments were 140,467 tons. The bookings for January and February this year were 20 per cent less than the corresponding months of 1948.

▲ Reductions are being made in the steel allocations program, thus reflecting the easing of the demand for steel.

▲ Voluntary allocations of steel have been cut 24 per cent or 95,500 tons monthly. The allocation for June, including all new programs will be 443,000 tons compared with 594,000 tons in February.

▲ The Republic Steel Corp. announced that two of its electric furnaces and one open hearth at it's Canton plant have been closed because of lessened demand for conversion ingots. An open hearth which produces alloy steel at Massillon is also down for repairs.

March 24

▲ Zinc prices were lowered to 16 cents a lb at East St. Louis for a cut of 1½ cents.

▲ Scrap prices in Pittsburgh are down to $36.00 a ton.

▲ The Inland Steel Co. reported that it reduced its price of galvanized sheets up to $4.50 per ton effective today.

▲ The Allegheny Ludlum Steel Corp. closed down an electric furnace and two open hearth furnaces at its Brackenridge, Pa. plant. It is expected that another open hearth will be shut off this week. Curtailment is due to slackening demand for alloy steel.

▲ The Carnegie-Illinois Steel Corp. announced because of the decrease in zinc prices coating extras for galvanizing sheet products will be reduced from 80 cents to $5.00 a ton. National Tube Co. made similar reductions.

▲ It was announced that the General Motors Corp. had leased a blast furnace from the Wheeling Steel Corp. located at Mingo Junction, Ohio. The furnace should be ready around July 1.

March 25

▲ The National Steel Corp. reported net earnings in 1948 of $40,121,506 which is equivalent to $16.35 per share.

▲ Howard C. Keiser, president of the Phoenix Apollo Steel Co., stated that they were planning to go out of business after July 1 unless they can find a new source of steel. The company cancelled its agreement with the Phoenixville Plant of the Kaiser-Frazer Corp. because of the high freight charges.

▲ The Federal Reserve Board announced that the index for industrial output declined in February to 189 per cent of the 1935-39 average compared with 191 per cent in January.

March 27

▲ Secretary of the Interior Krug recommended in his annual report a Federal Power Program which will cost from $12,000,000,000 to $15,000,000,000. He reported that 40,000,000 kilowatts of hydro-electric power should be developed in the next twenty years of which 75 per cent should be done by the government. The United States now has 17,000,000 kilowatts of water power capacity.

▲ Pig iron production in February totaled 5,169,904 net tons and operations averaged 96.5 per cent of capacity.

March 28

▲ Based on reports from companies having 94 per cent of the steel capacity of the industry, the operating rate is scheduled to be 99.8 per cent of capacity for the week beginning March 28, 1949. This is equivalent to 1,839,800 tons of steel compared with 1,863,800 tons one week ago.

▲ Henry Ford stated that auto prices are coming down and predicted that he will cut prices in 1949. His prediction depends on Union demands.

▲ About 463,000 coal miners started back to the pits.

▲ Federal Reserve Board announced reductions in stock margin requirements from 75 to 50 per cent. As a result stocks gained and the Dow-Jones Industrial average rose 2.40 points to 178.39.

▲ Refined copper dropped a one-fourth of a cent a lb to a post war high of 23½ cents. This is the first break in copper.

▲ The American Smelting and Refining Co. cut the price of lead for the third time this month to 17 cents a lb. This last cut was 1 cent per lb.

March 29

▲ Professor Gerard Letendre estimated that it will cost $1,400,000,000 to build a smelting and steel plant which will handle 10,000,000 tons a year of Ungava's proposed iron ore output. An electric smelting department would cost $300,000,000 extra. The Quebec government has therefore ruled it is more practical at the present time for private enterprise to bear the cost of opening up the mines and exporting it to the United States.

▲ Republic Steel Corp. reported that sales for 1948 were $772,000,000. Net earnings were $46,438,000 or $7.61 per share of common stock.

▲ The Westinghouse Electric International Co. entered an agreement with the government of the East Punjab province for the design and equipment of a 110,000 kva hydro-electric project.

March 30

▲ Net earnings for the Follansbee Steel Corp. for 1948 were $2,339,996 or $5.26 a share. Net sales were $36,739,240.

▲ The Inland Steel Co. reported record sales in 1948 of $392,708,370. Net earnings were $38,606,898 or $7.88 per share.

March 31

▲ The Alan Wood Steel Co. reported the largest net sales in its history of $47,480,574. Net income after preferred dividends and taxes was $4,116,444 or $7.78 per share.

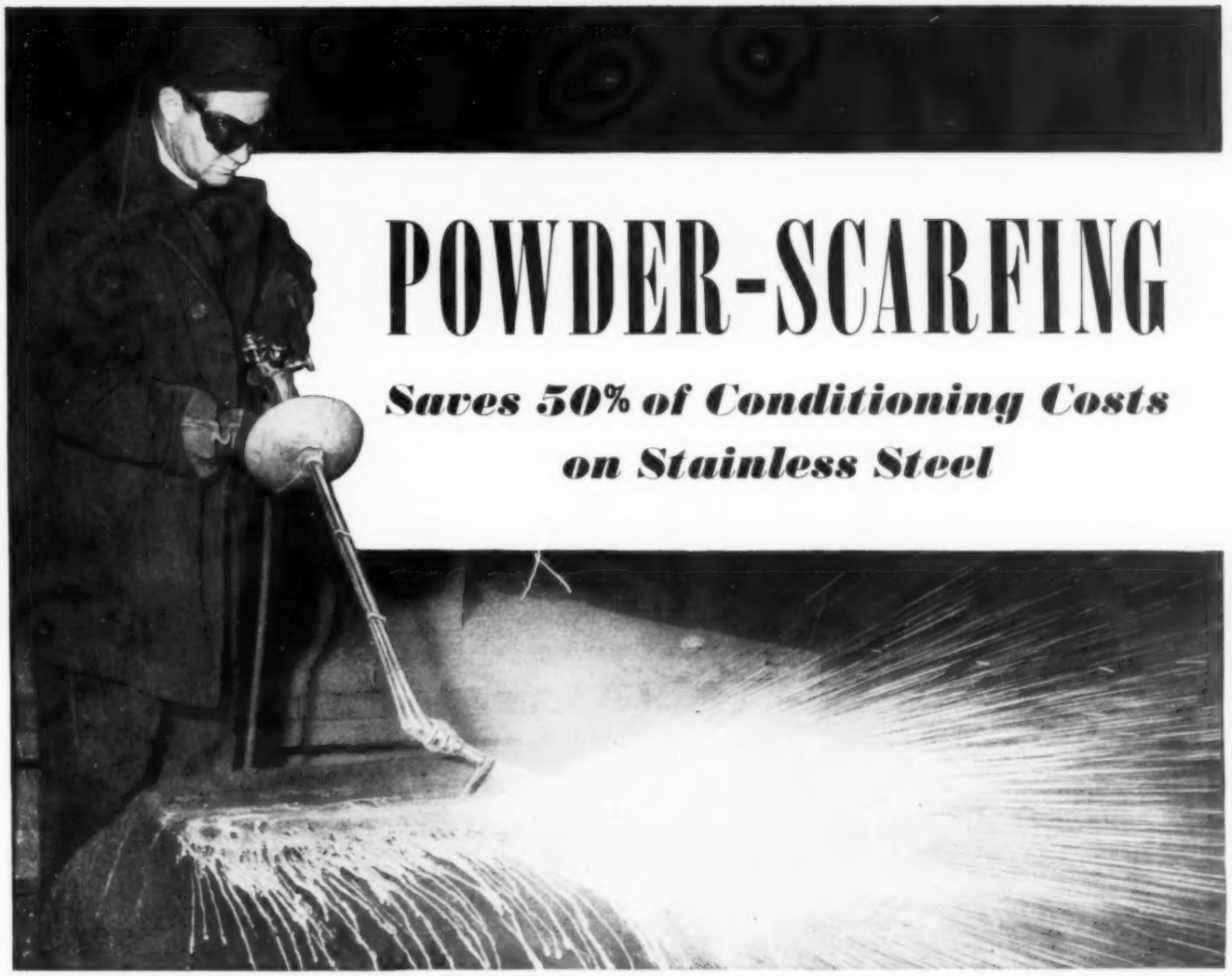
▲ Steel prices in Great Britain will be raised about 9 per cent in order that the government can drop subsidies which now amount to about $92,000,000 on imported scrap and iron ore.

▲ The Department of Commerce and SEC estimates that U. S. industry plans to spend $8,806,000,000 for new plants and equipment in the last half of 1949. This is about a 14 per cent drop for the same period in 1948. The expenditures for the first half of 1949 are estimated at $9,460,000,000.

▲ The Texas Eastern Transmission Corp. started work to increase the capacity of its natural gas pipe line system to 740,000,000 cu ft a day. Expansion will consist of several loops, extensions and more powerful pumping stations.

▲ Texas Gas Transmission Corp. of Owensboro, Ky. received permission from the FPC to build its Texas to Ohio natural gas pipe line. The company expects to have the $73,500,000 line in operation by the end of the year. The ultimate capacity of this 26 in. line is about 400,000,000 cu ft a day.

▲ J. Monroe Johnson, director of ODT, proposed that the government construct 550,000 new freight cars at a cost of $2,500,000,000. Cars will be either used by railroads or stock piled for war emergency.



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A-2027

Industry News...

REPUBLIC STEEL CORP. OBTAINS WEST AFRICAN IRON ORE SOURCE

▲Republic Steel Corp. has purchased a stock interest in the Liberia Mining Co., Ltd., a corporation of Liberia, West Africa, which has a concession about 45 mi northeast of the seaport capital, Monrovia.

The concession contains an extensive deposit of high grade iron ore available at ground level. The ore is a mixture of hematite and magnetite, assaying 68 per cent in iron and low in phosphorus, sulphur and silica. Average analysis of Lake Superior ore is about 51 per cent iron. Pure magnetite is 72.4 per cent and pure hematite is 70 per cent iron. The ore is found in hard masses which may be crushed into lumps suitable for open hearth charge and feed ore. Iron ore is used in open hearth furnaces to speed up reduction of the carbon during the steel making operation.

Development to date has been confined to a limited area which is known as the "Bomi Hills" iron ore deposit. This deposit has a cliff-like exposure of a mile or more extending above the surface from 30 to 100 feet. Extensive diamond drilling and surface exploration have revealed a substantial tonnage of this high grade ore. Until such time as additional diamond drill work has been completed, it is impossible to estimate with any great accuracy the expected tonnages which the deposit will yield.

Heavy expenditures will be required to bring this deposit into production, in addition to the cost of a railroad, now under construction, 45 miles in length from Bomi Hills to the port of Monrovia.

Terminals of the railroad, equipped to handle a million tons of ore a year, will be completed this October but the line itself will require about two years more.

Republic expects that ore from this property can be delivered to its steel making plants in Buffalo, Youngstown, Warren, Canton, Massillon, Cleveland, Chicago and Gadsden, Ala., to its advantage. The surplus beyond Republic's requirements will be marketed by the Liberia Mining Co. to the world trade.

The new ore source is about 45 miles northeast of the seaport capital, Monrovia.

ACID OPEN HEARTH GROUP ANNOUNCES '48 TONNAGE

▲ The Acid Open Hearth Research Association announces the total tonnage of acid open hearth steel melted for the year 1948 for both castings and ingots was 1,267,177 tons, 49.15 per cent of this is for ingots and 50.85 per cent for castings.

The tonnages previously reported are as follows:

1944	2,107,493 tons
1945	1,542,724 tons
1946	1,132,199 tons
1947	1,257,673 tons

COAL WASHING PLANT BUILT BY REPUBLIC

▲ Construction of a new coal washing plant in Russellton, Pa., has been completed by Republic Steel Corp.

The new coal washing plant will process coal mined at Republic's Russellton mine and the company's Indianola mine, located about eight miles away in the Freeport Seam area. This coal is coked and used in Republic blast furnaces in Canton, Massillon, Cleveland, Youngstown and Warren.

As a result of this construction,

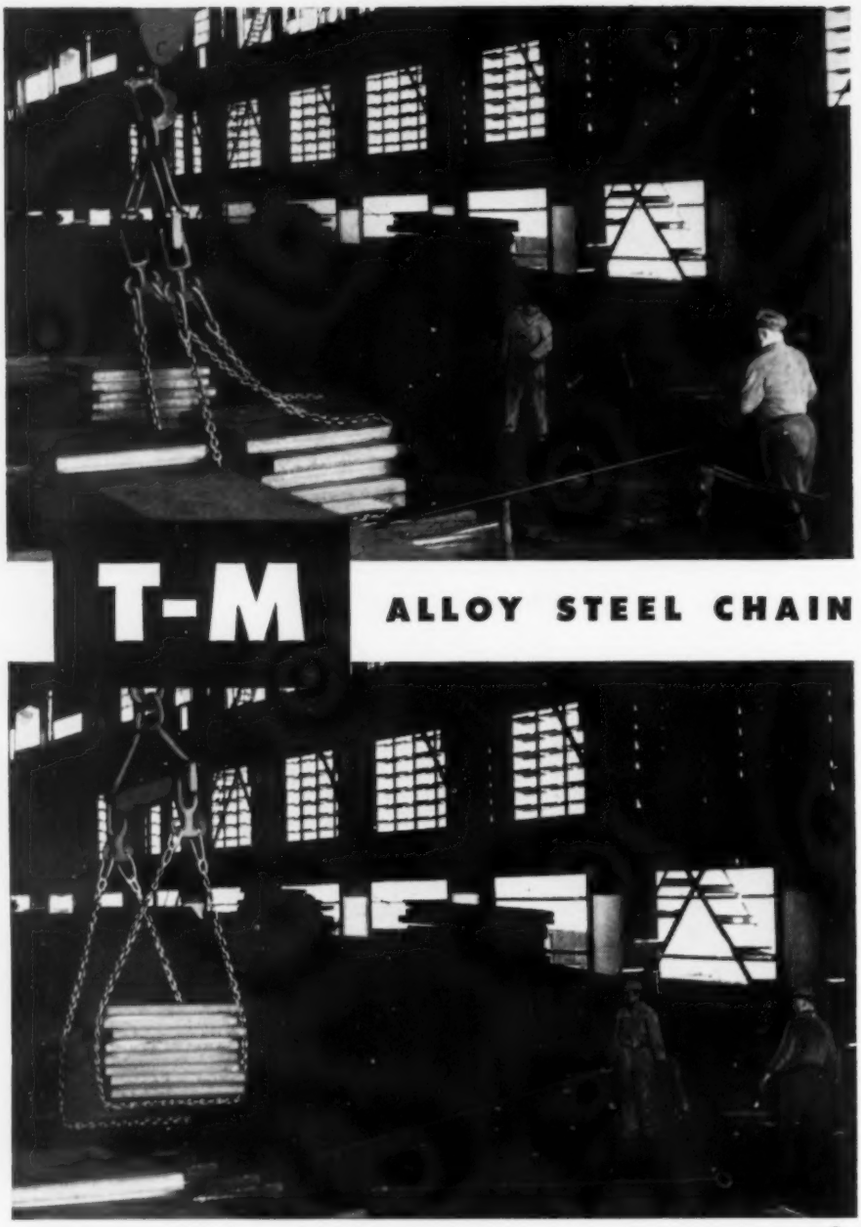
The new coal washing plant will handle 450 tons of raw coal per hour.

virtually all coal supplied to Republic's extensive Ohio steel making operations will now be improved through removal of impurities by washing. This will provide a more uniform quality coal for the company's blast furnaces and will permit better blast furnace operation with expected slight increase in pig iron output.

The coal washing plant will handle 450 tons of raw coal per hour. About 5500 to 6000 tons of washed coal are shipped per day. About 20 per cent of the weight of the raw coal, consisting of slate, bone coal and blackjack, is removed by washing.

Coal mined at Russellton is crushed to a maximum of 3½ in. and dumped from the mine tipple into a 200 ton bin. Coal from Indianola is crushed at the mine, brought by rail and dumped into a foreign coal bin. Both the Russellton storage bin and the foreign coal pit feed onto a 300 ft belt conveyor which carries the coal to the top of the coal washing plant. There the ¼ in. minus slack is screened out and washed separately on 16 Diester tables. This fine coal is dried and filtered in Bird Filters and then loaded in cars.

The coal above ¼ in. size is conveyed to flotation tanks containing a solution of water and sand at a specific gravity to furnish the desired quality of coal. The coal is floated off and passed over screens to remove



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the water and sand, then loaded into railroad cars for shipment. Sink material, or refuse, is conveyed to a refuse bin, then trucked to a refuse pile near the mine. Both sand and water are recovered and reused.

Republic also operates coal washing plants at its Clyde and Banning mines south of Pittsburgh, and at its Republic Kentucky mine. All coal produced in Republic's northern coal district is washed in one of the four plants except that coming from low volatile coal fields in West Virginia.

U.S. NOW LEADS WORLD IN BEARING MANUFACTURE

▲ The United States, once dependent on foreign sources for most of the ball and roller bearings on which the wheels of its industry turned, now is a leading supplier of anti-friction equipment to the rest of the world.

Approximately 10 per cent of the nation's output of bearings, according to William L. Batt, president of SKF Industries, Inc., is going into foreign markets to make up production deficits abroad.

He pointed out that the bearing industry, now operating at a rate of more than $300,000,000 a year, compared to $95,000,000 in 1939, exported more than $21,000,000 worth of bearings of all types and sizes in the first nine months of 1948. The bulk of these shipments went to Canada and Great Britain.

Canada and Britain alone, he said, accounted for more than $9,000,000 of U. S. exports. They were followed, in order, by Argentina, The Netherlands, Australia, Belgium, India, Switzerland, Mexico and Sweden.

C-I REBUILDS GARY NO. 4 BLAST FURNACE

▲ Carnegie-Illinois Steel Corp. announced that it is rebuilding and enlarging the No. 4 blast furnace at the Gary, Ind., steel works of this U. S. Steel subsidiary. The iron-making capacity of the blast furnace is being increased from 800 to 1500 tons and will make the stack rank among the world's largest. The company expects to have the enlarged furnace in production in October barring unforeseen delay.

The Gary plant has 12 blast furnaces and this is the second to be en-

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• Here is a new insulating fire brick, especially developed by the Johns-Manville Research Laboratory for use in forge furnaces, ceramic kilns, chemical process furnaces and other types of high-temperature equipment operating above the previous range of insulating fire brick.

Some of the more outstanding advantages of JM-3000 Insulating Fire Brick are: It is the highest temperature insulating fire brick made for backup or exposed use, effectively withstanding the full 3000 F. Its efficiency remains at a high level throughout the life of the brick. It has exceptional service advantages in many operations at lower temperatures where regular or special fire brick is ordinarily used.

With its combination of outstanding insulating and refractory properties, JM-3000 Insulating Fire Brick has been found to provide longer life, greater fuel economy and important savings in downtime. For further information, write to Johns-Manville, Box 290, New York 16, N. Y.

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Molded from high quality kaolin clays plus alumina
Density—63-67 lb per cu ft
Modulus of rupture—200 lb per sq in.
Linear shrinkage—(24 hr Panel test @ 3000 F) .8 per cent
Linear thermal expansion to 2000 F—.5 to .6 per cent
Pyrometric cone equiv.—Cone 37+ (3308 F+)
Temperature limit—3000 F
Conductivity (Btu in. per sq ft per F per hr at mean temp)

F	500	1000	1500	2000
Btu	3.10	3.20	3.35	3.60

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larged to the 1500-ton daily capacity, No. 6 having been placed in operation in July, 1947. No. 7 furnace was previously rebuilt in July, 1943, to 1350-tons daily capacity.

ARGENTINES BUILD SEAMLESS TUBE MILL

▲ A seamless tube mill with an annual rated capacity of 60,000 tons is under construction at Campana, near Buenos Aires, Argentina, as a part of the government-sponsored industrialization of that country. The production is designed primarily to produce seamless pipe for oil casing to replace a part of that previously imported.

The new Argentinian firm which will operate the mill has been incorporated as Societa Argentina Fabricacion Tubes de Acero, but design and construction will be by the Italian firm Techint, which operates in South America.

Mill equipment will include two modified Pilger mills of a new design which uses a special piercing press and are designed to produce 4 in. to 12 in. sizes. Two Dvorak push benches will produce smaller diameters up to 4½ in. Present plans call for the push benches to be in operation in 1950, and the project completed the following year. The 60,000-ton capacity represents the plan for the first construction unit. Further plans have been drawn for an eventual 100,000-ton capacity at some time in the future. It is estimated that the original unit will cost the equivalent of about $6 million in pesos.

Billets for the mill will be imported at least in the first instance, although consideration has been given to a plan for producing them in Argentina.

A matter of particular interest to the South American nation is the fact that the Italian firm, which has contracted to deliver an operating tube mill and keep it running until the Argentinian firm can take over, will be able to build the mill with only a limited draw upon dollar resources.

Techint has been organized in South America as a development company by a group of leading Italian industrialists and technicians since the war. It draws on all the resources of Italian heavy industry for its projects. It has already engaged in a wide variety of industrial construction projects in Argentina and other South American countries. A pipe line project is now half completed, and several power transmission projects are under way. The firm will build a steel fabrication shop in Argentina.

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REFRACTORY COMPANY REPORTS 1948 INCOME

▲ Consolidated net income of Harbison-Walker Refractories Co. and subsidiaries for 1948 was reported recently at $49,373,081. After dividends of preferred stock, this equalled $4.14 per share on the 1,334,995 shares outstanding, as compared with the 1947 net income equivalent of $3.73 per share on the number of shares outstanding.

A total of $5,712,257 was invested during the year on plant improvements and additions. Among the more important of these improvements were the completion of the company's new Baltimore, Md., and Fulton, Mo., works; increased capacities at Clearfield, Pa., Athens, Texas, and Portsmouth, Ohio, and the opening of a new quarry at Mt. Union, Pa.

Plant facilities were also improved at East Chicago, Ind., and Hays and Templeton, Pa.

Company subsidiary improvements included the completion of quarry facilities and tram extension for the development of the Red Marble Quarry at Chewelah, Wash., and the plans for quality improvement and doubled capacity of high grade magnesite at Cape May, N. J. A heavy-media separation plant at Kilmar, Que., which has assisted greatly in cost reduction, was also completed during the year.

CANADIAN FIRM BUYS TUBE TESTING UNIT

▲ The Page-Hersey Tubes, Ltd., in Welland, Ontario, Canada, has placed an order for a very large tube testing and expanding machine with Hydropress, Inc. Designed for a high and very economical production, this fully automatic machine will perform three operations in one, namely belling, expanding and testing tubes ranging up to 16 in. diameter and 51 ft length.

TWO COKE OVEN BATTERIES STARTED AT WARREN, OHIO

▲ Republic Steel Corp. put into operation the first of two new 40-oven coke batteries at Warren, Ohio, on April 1. Work has started on the second battery.

Republic is tearing out 64 old ovens. It had 61 others built in 1942. When finished, the plant will have a daily capacity of about 2500 tons of coke and will furnish about 1000 tons to Youngstown blast furnaces.

The coke program in Youngstown and Warren is costing about $15 million and is part of a long-range expansion in the area whose total cost may reach nearly $50 million. The program has included installing silicon steel rolling facilities at Warren, boosting capacity of the Niles, Ohio, plant, electrifying the bessemer plant in Youngstown, converting an old plate mill into a 48-in. hot strip unit and installing top pressure blowing techniques in blast furnaces. The Warren furnace produced a record average of 1468 tons daily in February.

Experience LOOMS LARGE
Mathews Engineers are Specialists in Heavy Materials Handling
• Steel men wouldn't trust an open-hearth heat to an inexperienced man. For such key functions they demand that experienced people be in charge — people who know exactly what they are doing.
So it should be with conveyers. Problems involving the efficient handling of coils, sheets or plates likewise require the attention of experienced people — specialists in heavy materials handling.
For many years Mathews Engineers have devoted the greater part of their time to the conveying problems of heavy industry. They have worked diligently to meet the requirements of steel plant engineers with heavy Roller Conveyers, Chain Conveyers, Roller Tables and a great many items of highly special heavy conveying machinery.
Today the Mathews organization makes available to Steel Mills and Foundries the facilities of three modern plants, and a wealth of experience in designing and building conveying equipment that will stand up under severe service.
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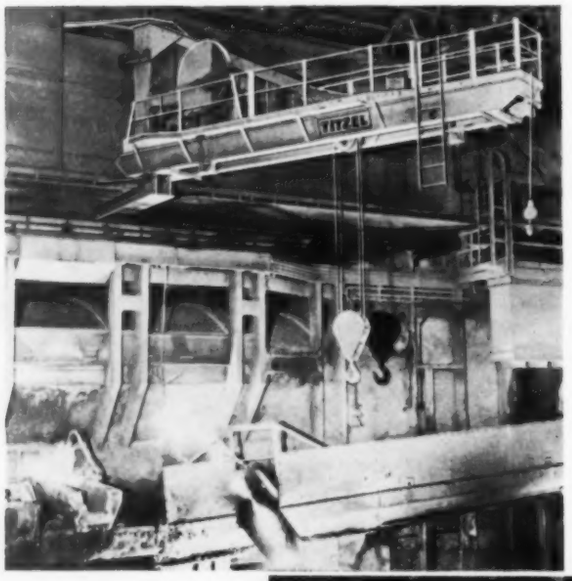
For dependable, trouble-free operation...

Titzel Steel Mill Equipment

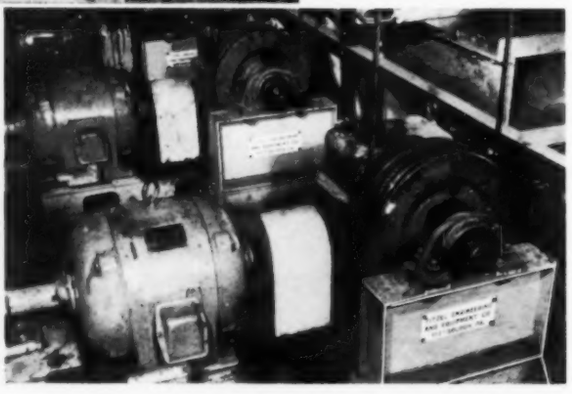


JIB CRANES

Titzel Jib Cranes are built to give maximum service with low cost maintenance. You can depend upon Titzel steel mill equipment to reduce your operational costs and increase your production.

DOOR HOISTS

Titzel Door Hoists give dependable trouble-free operation wherever they are installed. At the right, an installation of Titzel door hoists in the open hearth of a Pittsburgh district steel plant.



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▲ Delta-Star Electric Co. always has been a firm believer in the old adage, "one test is worth a thousand guesses."

Designers and users realize that as new equipment is developed, adequate testing plays an all-important role in its success. Facilities must be available so manufacturers may ascertain what service performance to expect. This advance knowledge should be available before final designs are approved for production. The facts can be obtained only through design tests. Routine tests constantly are required to check materials and parts entering into a product.

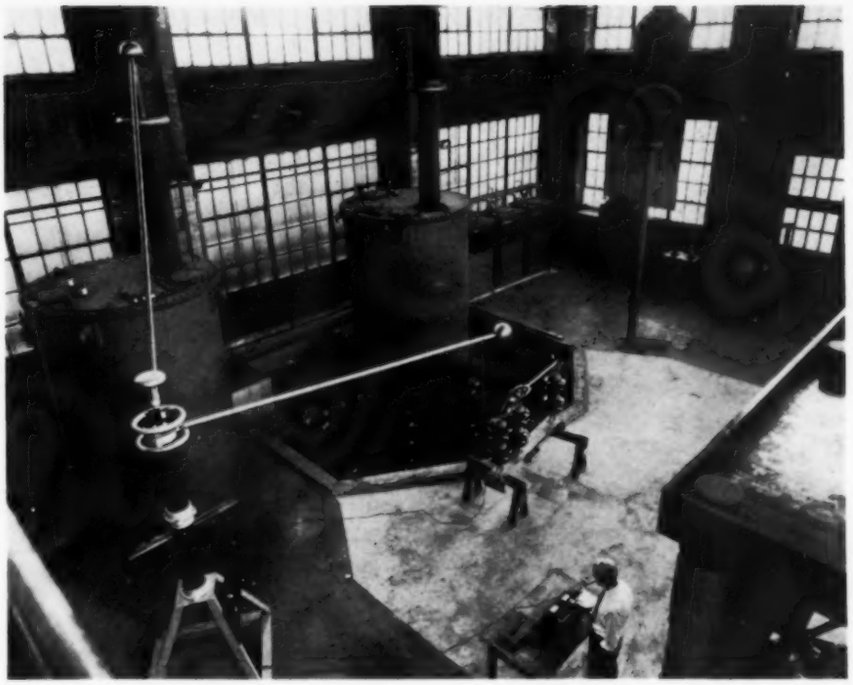
During early developments of high tension switching equipment, very meager information was available regarding high voltage phenomena, so Delta-Star built one of the first high voltage testing laboratories.

In recent years, great strides have been made in connection with coordination of insulation and the effect of electrical equipment on radio broadcasting reception. Concepts of high voltage testing necessarily have changed and impulse testing in lieu of 60-cycle flashover tests is now routine. The surge generator is no longer considered only as a piece of research equipment.

Radio interference was given little attention during early days of broadcasting, but this is a factor which must be considered by today's equipment designers. Through joint efforts of E.E.I., N.E.M.A., R.M.A. and other groups, definite recommendations as to methods and procedures for measuring radio interference voltage have been reached. This makes it possible for the manufacturer to test equipment under prescribed conditions to obtain data regarding effect on radio reception.

In recent years, war conditions have created new problems in connection with materials. Substitute materials require testing before being used to replace more critical materials, and the problem is complicated further by introduction of numerous new alloys.

During the past few years, a complete laboratory modernization pro-



Complete facilities are available for high potential testing up to 500,000 volts.

gram has been carried out at Delta-Star. This program included, among other items, installation of impulse testing equipment, radio interference testing equipment, high-speed cathode ray oscillograph, automatic Rockwell hardness tester and an optical comparator and measuring machine.

The laboratory is equipped with a Westinghouse square column type surge generator rated 1,000,000 volts, .025 microfarad. It is connected according to the "Marx" principle wherein a battery of capacitors is charged in parallel from a d-c source and then discharged in series by flashing over cross-connected series gaps. The d-c charging source is obtained through two 50-kv kenotron tubes fed from a transformer.

The design is such that four micarta supporting columns hold the capacitor shelves. Ten capacitor units are used, each rated 100 kv. Five central columns carry adjustable gaps which are motor operated, and controlled from main control panel. Means for adjusting wave shape of the impulse are available and safety features warn operators when the set is in operation.

A high speed Westinghouse cathode ray oscillograph of the so-called "cold" type records surge voltages during test. Photographic film is

WELDCO
MECHANICAL PICKLER

CUTS PICKLING COSTS 35% AT CANADIAN DRAWN STEEL COMPANY

● Shown here in the "down" position is a Weldco Mechanical Pickler in the plant of the Canadian Drawn Steel Co., Ltd., Hamilton, Ontario. This 5-ton Bar Pickler pickles 15 to 20 tons of rounds, hexagons, squares, and flats per hour, in lengths up to 35 feet. Easy to operate and control, it saves 25% pickling time, eliminates the need of an overhead crane for agitation, and increases tonnage with reduced manpower.

Weldco Mechanical Picklers are also available for pickling coils, tubing, and sheets . . . can be built to any capacity, to fit any type of plant. Why not find out how Weldco can save manpower, maintenance, and money for **you?** Write today for further information and descriptive literature.

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"MULTICUT" "TUFCUT" "HOT WORK"
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SHEAR BLADES
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Any type or size blade of proper Alloy with correct hardness and temper for every type shearing machine and every kind of job.
Rx ENGINEERED TO THE JOB
Every Wapakoneta blade is made to exact specifications, designed for the particular job. Complete records with order number of each blade makes possible duplication of exact size and temper at any time.
The WAPAKONETA MACHINE CO.
Shear Blade Specialists Since 1891
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directly exposed to the cathode beam, permitting extremely high writing speeds—20 in. per microsecond being not uncommon. Completely automatic accessories are used. When coupled to the surge generator, the oscillograph circuit is such that recording starts within two-tenths of a microsecond after arrival of a single electrical impulse of either polarity.

To meet the demand for hardness tests on materials going into war products, Dela-Star has supplemented the Scleroscope with an automatic Rockwell Hardness Tester equipped with a zerominder device to permit production testing.

The optical comparator, a device permitting inspection of measurement by magnified silhouette projection of the piece under examination, provides a fast and accurate means of checking many forms that are difficult, if not impossible, to measure by direct gaging. This instrument is of great value for measuring complicated forming tools, hobs, taps, thread chasers and gages.

Projection inspection also is used extensively for ordinary production inspection, due to the ease and rapidity of handling this type of work.

GRANITE CITY INSTALLS RADIO-TELEPHONE SYSTEM

▲ The installation of a radio-telephone communications system to control railroad movements in the plant area of Granite City Steel Co. was completed recently and is now in full operation. The steel company operates four locomotives to service its mills at Granite City, Ill., hauling more than a million tons of material annually.

The new communications system will save both time and money and will provide much more efficient railroad service to every operating department in the plant area.

A special channel or frequency has been assigned to Granite City Steel by the Federal Communications Commission. The frequency is ultra-high, on 154.49 megacycles.

A fixed station identified by the call letters, WGDF, and having a power of 50 watts has been installed in the yardmaster's office. Mobile units powered by 30 watts and including a transmitter and receiver have been installed in each of the

four locomotives operating on the mill's railroad system. Engineers will use the call letters, WGDG, with a number suffix to identify the particular locomotive.

A dispatcher in the yardmaster's office can call one or more engines and relay instructions at any time of the day or night. Engineers can call into the yardmaster's office or can contact each other.

A second major improvement in the Granite City Steel railroad system is the purchase of a new 80-ton, 650-hp diesel electric locomotive. Delivery on the diesel is expected within the next few weeks and an old-type steam engine will be retired when the new locomotive goes into service. Granite City Steel Co. has one other 80-ton diesel electric, one 40-ton diesel electric, and two steam locomotives.

The railroad serving the plant is a standard gage road and approximately 75 men, including operating crews, office workers, and repairmen are needed to keep the system in operation.

TENTH WATER CONFERENCE TO BE HELD IN OCTOBER

▲ The Tenth Annual Water Conference of the Engineers' Society of Western Pennsylvania will be held in the Hotel William Penn, Pittsburgh, Pa., on October 17, 18, 19, 1949.

BILLET HEATING FURNACE TO BE BUILT AT CFI

▲ A double-fired billet heating furnace with a top outlet for waste gases has been designed and will be built at Pueblo, Colo., for Colorado Fuel & Iron Corp. by Rust Furnace Co.

The furnace, designed for a maximum temperature of 2500 F, will have a capacity of 60 tons per hour when heating 24 ft billets. It is designed so that waste gases will leave through a top outlet at the charging end into brick lined steel flues connected to the stack. It will serve a new rod mill.

The furnace, with an overall outside length of 73 ft 3 in., has an inside width of 26 ft with an effective heating length of 65 ft.

It is expected that construction will begin early this year, according to Rust engineers.

Service proved for all steel mill requirements

● The view at the left above shows Quick-As-Wink Valves operating the pallet conveyor tilter, mandrel type feed reel carriage, and lowering and raising elevator on a 3/16" x 68" hot mill rotary flying shear. View at the upper right shows two 3-way Quick-As-Wink valves for a 56" rotary shear hydraulic piler. The view at the lower right above shows the control for a pallet conveyor tilter, feed reel hoist, and clamping mechanism on a 68" 2-high skin pass mill.

Other Quick-As-Wink valves are being used on run-out tables, mill stands, coilers and a wide variety of other steel mill equipment.

Furnished in hand and pilot cylinder operated designs for every industrial application. Let us quote on your requirements.

Quick-As-Wink Lever Operated Hydraulic Valves

The HS-551-N4 pictured above is a neutral position 4-way valve for controlling double acting cylinders. It has a machined steel housing, chrome plated and polished stainless steel plungers, and renewable metal rings to take the impingement of the liquid flow preventing wear on the U-packers. Used for oil or water up to 3500 P.S.I. and 150° F. Other valves available for pressures up to 5000 P.S.I.;—but send for a catalog today and get *full* details about the *complete* line.

Quick-As-Wink Control Valves

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Manufactured by **C. B. HUNT & SON, Inc.,** *Salem, Ohio.*

Engineering and Sales Representatives in the Principal Cities

PITTSBURGH PIPE CLEANER CO.
Goes Into Sewers To Take Pictures

The above illustration shows how far Pittsburgh Pipe Cleaner Company will go to make a COMPLETE survey of sewer problems.

This photo actually taken inside of a large industrial sewer shows how the face brick has fallen out, the mortar between the brick is gone, and the conditions below the water line are even worse.

This is only one of a series of pictures taken within this same sewer, and they all show similar or worse conditions.

Write to our engineering department today for complete information regarding this type of survey.

Pittsburgh Pipe Cleaner Company offers Today the most Complete Engineering Service available in the Industrial Water Supply and Disposal Fields

PITTSBURGH PIPE CLEANER COMPANY

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BALTIMORE • BIRMINGHAM • BOSTON • BRADENTON, FLORIDA • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI
DETROIT • HOUSTON • NEW YORK • PHILADELPHIA • ST. LOUIS

POSITIVE INSULATION

. . . for live rails

KEYSTONE CONTACT RAIL INSULATORS SUPPORT CONDUCTORS IN HEAT, SLEET, AND SNOW

From the high temperatures near soaking pits to constant exposure in rain, sleet, or snow—Keystone Contact Rail Insulators provide constant insulation and allow for expansion and contraction of contact rails.

Type BOA, shown here, is designed for over-running service . . . at voltages below 750 . . . where unusual mechanical strength is required. Its heavy glazed wet porcelain block provides unfailing support and insulation. All metal parts are hot galvanized. Clamps are designed to permit free movement of rails. Easy to install, Type BOA is the perfect answer to rail insulation problems in steel plants across the country.

For your cranes, conveyors, and other electrical hoisting and hauling systems, Electric Service manufactures a complete line of insulators, collectors, and rail shoes . . . used with rails, angles or wires as a conductor. Details on the complete line are available in our free, 300-page illustrated catalog. Write for your copy today.

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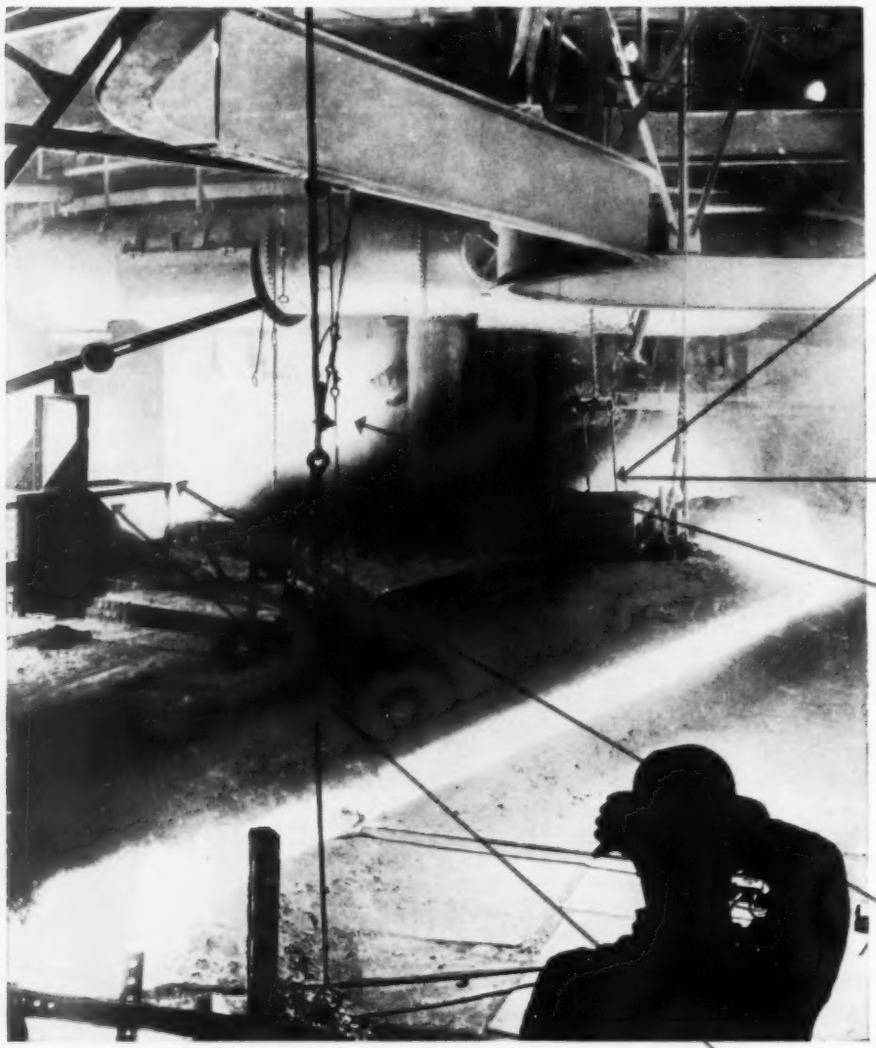
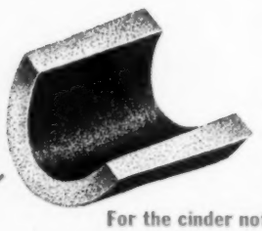
1721 CAMBRIA ST. PHILADELPHIA 32, PA.

COLLECTORS · RAIL SHOES · RAIL INSULATORS · CABLE STRAIN CLAMPS · SHOP TOOLS

WHEREVER THE HOT STUFF HITS

USE CARBON



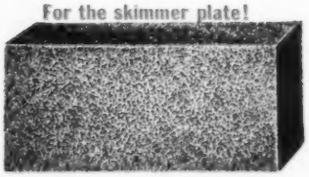


For the cinder notch liner!

For the cinder notch plug!

For the splash plate!

For the runout troughs!



For the skimmer plate!

● "National" carbon is now firmly established for blast furnace linings. It is being used outside the furnace as well—wherever there is contact with molten material—for the splash plate, runout troughs clear down to the ladle, skimmer plate, cinder notch liner, and cinder notch plug.

The reasons?

"National" carbon has no melting point. It is highly resistant to slag attack and thermal shock . . . not wet by molten metal . . . has a low thermal expansion . . . and maintains its mechanical strength at elevated temperatures.

Use "National" carbon inside and outside your blast furnaces and you cut down maintenance, speed up production and save money. For more information, write to National Carbon Company, Inc., Dept. IS.

The term "National" is a registered trade-mark of National Carbon Company, Inc.

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Unit of Union Carbide UCC *and Carbon Corporation*

30 East 42nd Street, New York 17, N. Y.

Division Sales Offices:

Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

These products sold in Canada by Canadian National Carbon Company, Ltd., Toronto 4

Personnel News...

James M. Darbaker has been appointed general manager of sales, Carnegie-Illinois Steel Corp., Pittsburgh, Pa. Mr. Darbaker, since 1947, has been manager of operations, Chicago district.

Stephen M. Jenks, general superintendent, Gary works was appointed manager of operations for the Chicago, Ill., district of Carnegie-Illinois Steel Corp., with headquarters in Pittsburgh, Pa.

L. M. Gumm was appointed metal working consultant for the industrial sales department, Westinghouse Electric Corp., East Pittsburgh, Pa. Prior to this new assignment, and for the past eleven years, Mr. Gumm has been manager of the steel mill and metal working section of the industrial sales department.

K. M. Patterson was named manager of the steel mill and metal working section of Westinghouse Electric Corp., East Pittsburgh, Pa. Mr. Patterson, a graduate of the Georgia Institute of Technology with a B.S. in electrical engineering, joined Westinghouse as a graduate student in 1923. Since completion of the graduate student course, he has been engaged in sales activities of large motor apparatus and comes to his new assignment from the position of special representative in the transportation and generator division. For many years he has been in very close contact with the steel mill and metal working industries in the development and sale of main rolling mill drives. He brings to his new assignment a broad knowledge of the industry and its apparatus requirements.

William J. Grattan, 75, retired assistant mechanical superintendent, Algoma Steel Corp., Toronto, died recently.

Alwin F. Franz has been appointed executive vice president of the Colorado Fuel & Iron Corp., Denver, Colo., and its subsidiary companies. Mr. Franz has recently been elected a director of the corporation. Previous to 1945, when he joined Colorado Fuel & Iron, he had been associated with Alan Wood Steel Co., where he served as general superintendent of the steel division. **Jay J. Martin,** works manager of the Pueblo plant, has been named vice president in charge of operations for the corporation and subsidiaries. Mr. Martin came to CF&I in 1926 from the Youngstown plant of Carnegie-Illinois Steel Corp., where he served as first helper in the open hearth department. Mr. Franz and Mr. Martin continue to maintain headquarters at Pueblo, although Mr. Franz maintains a similar office in Buffalo. **John S. Hawley** has been appointed assistant to the executive vice president of CF&I, with headquarters in Buffalo. Mr. Hawley, formerly in charge of operations in the California Wire Cloth Corp., a California subsidiary, had been assistant to Mr. Franz during the time the latter was vice president in charge of operations.

A. M. Tredwell, Jr., has been made assistant to the president and director of personnel, Sharon Steel Corp., Sharon, Pa. Mr. Tredwell joined the company in 1930 and has served in various capacities in industrial engineering, industrial relations and personnel work. **J. D. Neuman** has been made assistant vice president. Mr. Neuman started with Sharon in 1931 and for the past three years has been director of purchases and general assistant to the president.

Ronald E. Griffiths, for three years supervisor of the American Steel & Wire Co. research laboratory in Cleveland, Ohio, has been appointed assistant director of research for the company.

Stanley M. Hunter was elected to fill the newly-created position of executive vice president of the American Hoist & Derrick Co., St. Paul, Minn.

K. S. Kuka was recently promoted to the position of superintendent, electrical engineering and construction at Tata Iron & Steel Co., Ltd., Jamshedpur, India. He joined Tata Iron & Steel Co.'s works in 1940 as a probationer, after having obtained his training in electrical engineering in the Siemens Schuckert works in Germany. Mr. Kuka is a graduate of University of Bombay and the Indian Institute of Science.

Roy Perkins, veteran construction superintendent, has been appointed manager of F. H. McGraw & Co.'s blast furnace department.

Paul J. Welsh has joined the research staff of E. F. Houghton & Co., Philadelphia, Pa.

Donald N. Hildebrand has been named assistant superintendent of the continuous tube mills, Republic Steel Corp., Youngstown, Ohio, succeeding Roy Case.

JAMES M. DARBAKER

STEPHEN M. JENKS

L. M. GUMM

K. M. PATTERSON

Kling
ROTARY SHEARS
DO MANY TYPES OF WORK
DOES ALL THIS WORK FOR YOU
1 CUTS STRAIGHT LINES
2 CUTS RINGS-SMALL OR LARGE RADII
3 CUTS CIRCLES
4 MAKES FLANGES
5 CUTS INSIDE HOLES WITHOUT CUTTING IN FROM EDGES
6 JOGGLES & OFFSETS
7 CUTS ODD SHAPES
8 BEVELS OF ANY ANGLE
9 CUTS REVERSE CURVES
10 BEADS & U'S
ALL WITH Hairline PRECISION

Yes, and With Hairline Precision

Rapid operation . . . Hairline Accuracy . . . the use of Kling Rotary Shears marks the latest development in cutting mild steel, and sheet metal, up to 1-inch with amazing savings in time, labor and production costs.

For exacting projects (see illustration at the right), no single unit of metal-working equipment does so many different things so cleanly and efficiently as does the Kling Rotary, pictured above.

In metal-working plants, automotive, aviation, home appliance, and other industries, where work of this character is being done — this machine is held in high regard for its versatility and economy of operation.

This great usefulness is the result of half-a-hundred years of engineering experience which prospective buyers, with reason and respect, applaud.

Send Today for Bulletin No. 245 which will give you specific facts, and specifications. No obligation involved. Users of heavy equipment of Kling Rotary Shears' class will receive a copy of this Bulletin promptly, on request.

KLING BROS. *Engineering Works*

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EXPORT DEPT. 1111 South Ferry Building, New York 4, N. Y.

Dr. Willard D. Peterson announced his association with Arthur D. Little, Inc., Cambridge, Mass. Dr. Peterson was previously associate director of research and development at J. T. Baker Chemical Co.

M. H. Blank was appointed representative for Farrel-Birmingham Co., Inc., in the Detroit area to handle the sale of gears and gear units manufactured at the company's Buffalo, N. Y., plant. Mr. Blank, whose offices are located at 901 Lafayette Building, Detroit 26, Mich . has been engaged in sales engineering activities as manufacturers' agent in and around Detroit for the past few years.

Paul G. Pendorf, who had retired January 1, 1948, has been recalled to take his former position as Pittsburgh district manager for Carbone Corp. Mr. Pendorf is located at Room 4035, Jenkins Arcade, Pittsburgh 22, Pa.

John H. Loux has resigned his connection as Chicago representative with Loftus Engineering Corp. in order to devote his full time to the installation of industrial

JOHN H. LOUX

communication and electronic equipment for Farmers Engineering & Manufacturing Co. Mr. Loux will retain his offices at 185 North Wabash Ave., Chicago, Ill.

Kenneth K. Kenzel was appointed manager of Republic Flow Meters Co.'s Cincinnati district office, located at 3197 Linwood Ave., Cincinnati 8, Ohio.

E. Corbin Chapman was named chief metallurgist of Combustion Engineering — Superheater, Inc., New York, N. Y. Mr. Chapman has been employed by Combustion since his graduation from Cornell University in 1928.

Joseph A. Marland who has been handling sales in the Chicago territory, has been made sales manager for W. A. Jones Foundry and Machine Co., Chicago, Ill., and **Thomas A. Jones** has been appointed assistant sales manager. **Joseph A. Guyer,** who has been handling general work in the sales and advertising departments is now advertising manager.

Everett G. Parmele, formerly of the Dallas office, has been promoted to district manager of the Chicago office for Electric Service Manufacturing Co. The office is

now located in the Railway Exchange Building in Chicago, Ill.

Fred W. Acker, assistant superintendent, electric and power department, Inland Steel Co., Indiana Harbor, Ind., has retired.

Douglas P. Tracy has joined the Youngstown Sheet and Tube Co. as assistant superintendent of the seamless hot mills at Campbell, Ohio, works.

John H. Vohr, who has been assistant general superintendent of the South Chicago plant of Carnegie-Illinois Steel Corp. for the last four years, has been promoted to the general superintendency of Gary, Ind., steel works.

JOHN H. VOHR

Edwin H. Gott, who has been assistant general superintendent of the Gary plant of Carnegie-Illinois Steel Corp., since 1945, will be transferred to South Chicago works as assistant general superintendent.

Richard S. Moore was named manager of basic sales for Harbison-Walker Refractories Co., Pittsburgh, Pa. He has been connected with the basic sales department since 1940.

Edward L. Fortin and **James Kniveton** have been elected vice presidents of Selas Corp. of America, Philadelphia, Pa. Mr. Fortin will continue as treasurer, in addition to his new office. Mr. Kniveton, an engineer, will assume greater responsibilities for the development of special-purpose gas processing equipment in cooperation with industry development engineers.

J. Clarence Kimpel, formerly secretary and treasurer of the C. M. Kemp Manufacturing Co., Baltimore, Md., was elected president and chairman of the board, succeeding the late **Wallace W. Kemp. Edward J. Funk, Jr.** was elected vice president. He will continue in his capacity as chief engineer. **Charles E. Wilbur,** formerly assistant secretary and treasurer, was elected secretary and treasurer.

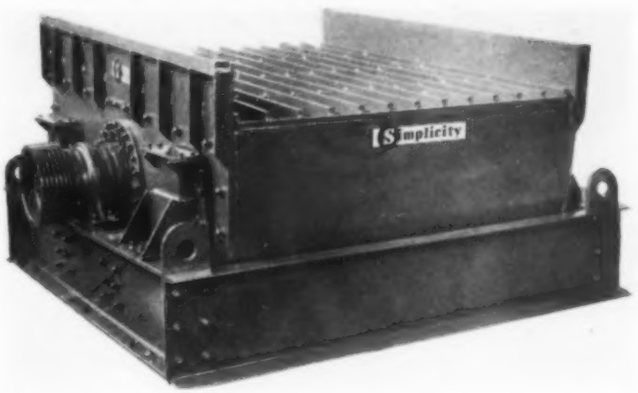
Norman F. Tisdale, chief metallurgical engineer of the Molybdenum Corp. of America since 1933, has now been made manager of sales.

Philip E. Berens has resigned as manager of Electro Chemical Corp. to accept an appointment as district manager of materials of chemical construction sales in the eastern Pennsylvania and western New York territory of Atlas Mineral Products Co.

Shake Outs and Screens

KNOCKOUT

Ordinary Greases



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NON-FLUID OIL

TRADE MARK REGISTERED

Lubricates dependably until entirely used up!

NON-FLUID OIL "F-925" has proved to be cheap insurance for bearing life in this type of equipment in principal foundries throughout the country.

Super-adhesive NON-FLUID OIL is made to withstand the violent shocks and terrific vibration of shakeout machines. NON-FLUID OIL, through its exclusive adhesive properties, stays in bearings and protects against friction long after ordinary greases have been "knocked out" or become "dead."

We invite you to send for testing samples which prove our claim that NON-FLUID OIL stays "alive" l-o-n-g-e-r, outlasting ordinary lubricants 3 to 5 times.

NEW YORK & NEW JERSEY LUBRICANT CO.

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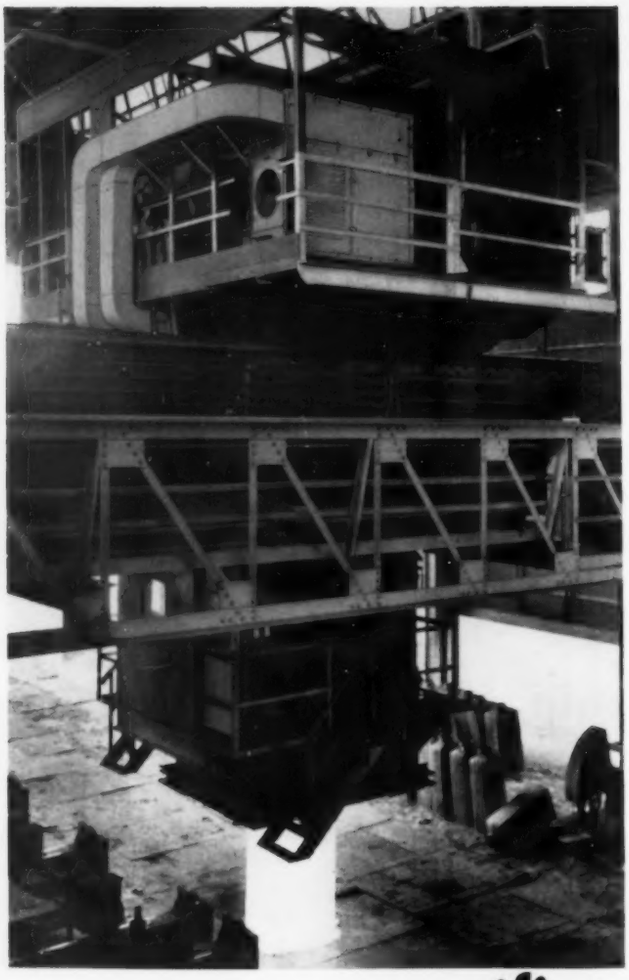
WORKS: Newark, N. J. WAREHOUSES: Charlotte, N. C. — Greenville, S. C. — Atlanta, Ga. — Providence, R. I. — Detroit, Mich. — Chicago, Ill. — St. Louis, Mo.

NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.



Lintern Aire-Rectifier
for Soaking Pit Crane Cab

This soaking pit crane in the plant of a prominent steel company, near Baltimore, is equipped with a Lintern Aire-Rectifier with air-cooled condenser. This installation, typical of many others, went through 1947 and 1948 with excellent results. This type of Aire-Rectifier,with air ducts, is suitable for many locations. It has been followed by several installations in this area, including the later models, such as AC-49-27, in which costly air ducts have been eliminated with savings up to 30 per cent.

Whatever your requirements are, whatever your installation problems may be, we have a model exactly suited to the job at the lowest *total* cost to you.

THE LINTERN CORPORATION
54 LINCOLN AVENUE • BEREA, OHIO

John M. Mulholand has been appointed traffic manager of Youngstown Sheet and Tube Co. at Chicago, Ill. Mr. Mulholand previously served as manager of railroad sales.

Robert E. Rielly has joined Chas. Taylor Sons Co., Cincinnati, Ohio, as assistant to the vice president in charge of sales.

Robert H. Hoge, president of Clark Controller Co., Cleveland, Ohio, and also president of Canadian Controllers, Ltd., Toronto, Can., announces the following new members of the board of directors of Canadian Controllers, Ltd.: **R. L. Puette,** vice president of Clark Controller Co., Cleveland, Ohio; **W. E. Foreman,** vice president and general manager of Railway & Power Engineering Corp., Ltd., Toronto, Can.; **S. A. Williams,** secretary-treasurer of Railway & Power Engineering Corp., Ltd., Toronto, Can.; **William I. Turner,** vice president and general manager of Canadian Controllers, Ltd.

Harold A. Muttach has been appointed general superintendent of the Koppers Co., Missouri-Illinois plant, Granite City, Ill. **John E. Brown** replaces Mr. Muttach as blast furnace superintendent and **James E. Oesterle** has been promoted to coke plant superintendent. Mr. Brown and Mr. Oesterle had both served as assistant superintendents in their respective departments. **George W. England, Jr.** has been promoted from blower to assistant blast furnace superintendent and **John J. Pistrui** has been appointed assistant coke plant superintendent. He had formerly served as foreman of general by-products.

LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS

Only 3 PARTS

To Handle In Renewing Link

WARE HI-LAG FUSE Construction establishes a top standard for rugged simplicity. There are only 3 PARTS to handle to replace blown link:—the Fibre Case—the Knife-Blade Assembly—the Closure Ring. Only 1 wrench needed to loosen nuts and slip out blown link. Assembly can be inserted either end in Case.

Write for Circular — APPROVED BY UNDERWRITERS LAB

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TOP-QUALITY ELECTRODES ARE EASY TO RECOGNIZE . . .

The ⟨ICE⟩ trademark stamped in the socket identifies top-quality electrodes immediately and signifies the most progressive methods known in the art of producing graphite electrodes. For at International, all phases of the manufacturing cycle are carefully controlled to assure the most desirable characteristics . . . electrodes and nipples are checked chemically and mechanically for top-quality and uniformity . . . threads are "miked" to eliminate misfits. There are no better graphite electrodes than International . . . none better for performance . . . none better for economy, that's why so many melters use them consistently.

Graphite products for electrothermic and electrolytic applications

⟨ICE⟩ *International* **GRAPHITE AND ELECTRODE CORP.**

ST. MARYS, PA.

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CARDOX

Indoors and Out

FIRE PROTECTION for STEEL PLANTS

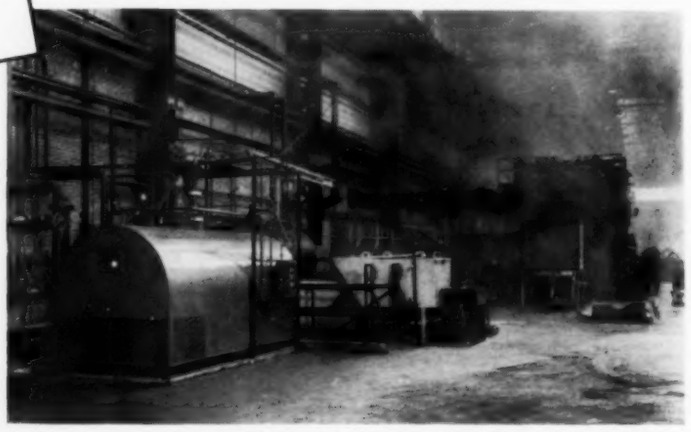
Typical Steel Plant Oil Cellar hazard protected with a Cardox System utilizing a 4 ton carbon dioxide storage unit.

● Using low pressure carbon dioxide —applied with equal facility in *pounds* or *tons* — Cardox Fire Extinguishing Systems and Mobile Equipment provide complete protection of such typical steel plant hazards as Oil Cellars, Oil Storage, Generators, Transformers, Mill Motors, Cable Tunnels, Mill Stands, Quenching Operations, etc.

CARDOX Low Pressure Carbon Dioxide Fire Extinguishing Systems* and Mobile Equipment* provide unique advantages in fast-acting, non-damaging protection for steel plant fire hazards. Write today for Bulletin No. 449.

**Covered by issued and pending patents.*

Cardox protected steel plant oil storage room. A single Cardox System protects numerous hazards, indoors and out.



4-Ton Cardox Carbon Dioxide Storage Unit. These units are available in capacities from 500 pounds to 125 tons.

Cardox Fire Truck makes tons of Cardox CO_2 quickly available for widely separated hazards.

WHY DON'T YOU WRITE TODAY FOR FREE SURVEY AND CONSULTATION

CARDOX

CO_2 FIRE EXTINGUISHING SYSTEMS

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DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Wheeling • Cleveland • Detroit • St. Louis • Chattanooga • Los Angeles • San Francisco • San Diego

W. H. Seaman, president of the National Roll & Foundry Co., was elected chairman of the board, and will continue to serve as president. **Robert Logie,** treasurer of the company, was also elected executive vice

W. H. SEAMAN

president. **Frank C. Nash** was named secretary and **Nolan P. Banner, Jr.,** assistant secretary.

C. E. Homer, formerly electrical superintendent at the Indiana Harbor works of the Youngstown Sheet and Tube Co., was made superintendent of maintenance and power.

S. W. Corbin has been appointed assistant manager of the industrial divisions of General Electric's apparatus department. Mr. Corbin also is manager of the resale industries division, a position he assumed in 1943 and will retain along with his new appointment. He served as sales manager of the machinery manufacturers section of the industrial department from 1937 to 1943.

Melvin C. Harris has resigned as vice president in charge of production, Allegheny Ludlum Steel Corp., Pittsburgh, Pa. Pending the election of his successor, **C. B. Pollock,** production manager, is in charge of production for the company. Mr. Harris has been manager of production since 1946.

N. A. Hansen, formerly assistant superintendent of the Jones & Laughlin Steel Corp.'s Aliquippa works rod and wire department, has been appointed superintendent of that department. He was first employed by J & L in 1926 and has been with the rod and wire department since 1929.

F. D. Wilkins, formerly general foreman of the rod and wire department, Aliquippa works, Jones & Laughlin Steel Corp., has been appointed assistant superintendent of the department. Mr. Wilkins joined the Aliquippa works in 1927 and served in various positions until he was appointed general foreman of the rod and wire department in 1946.

Charles DeZutter has been appointed superintendent of the bessemer finishing and rolling mills for Republic Steel Co., Youngstown, Ohio, and **E. H. Callahan,** assistant superintendent. **Charles R. Leonard** has been appointed assistant superintendent of the electrical department.

high ratios ?

ONE OF 93

DE LAVAL
DOUBLE REDUCTION WORM GEARS

De Laval double reduction speed reducers, consisting of combinations of double worm gear reductions, or helical and worm gear reductions, are available with overall ratios up to approximately 8000 to 1. De Laval single reduction worm gear speed reducers are available in ratios up to 90 to 1. If high ratios are your requirement, worm gear speed reducers are the answer—particularly if space is limited and reliability is important. A De Laval representative will help you pick the right size and type.

This double reduction De Laval Worm Gear Speed Reducer is available in many standard ratio combinations, with horizontal or vertical output shafts and is but one of 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

WG-14 **DE LAVAL**

Worm Gear Division: De Laval Steam Turbine Co., Trenton 2, N.J.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS
CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

Robert E. O'Brien has been named district representative in the Cleveland, Ohio, territory by Heppenstall Co., Pittsburgh, Pa. According to **John P. Roche**, vice president in charge of sales, when Mr. O'Brien moved

ROBERT E. O'BRIEN

to Cleveland, April 1, **Jack R. Allen** left the employment of Heppenstall Co. Mr. Allen has established a manufacturers' representative office in the Swetland Bldg., Cleveland, after a 15 year association with Heppenstall Co.

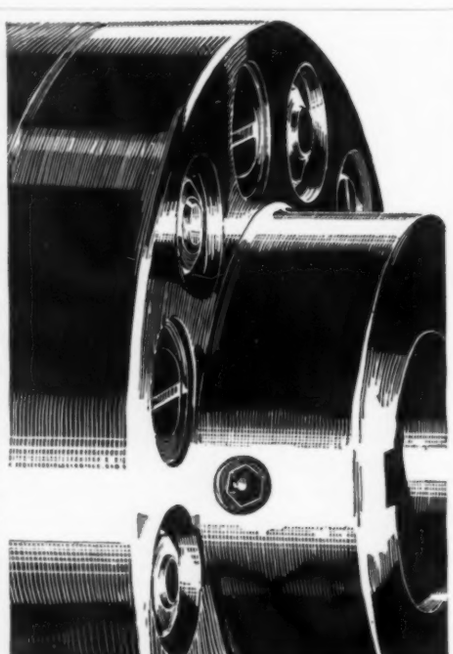
Harold S. Dunn, Pittsburgh district sales manager of Harbison-Walker Refractories Co., has been appointed general sales manager. Mr. Dunn has been district sales manager since August when he was promoted from sales manager of the Portsmouth, Ohio, district.

W. G. McClain of Furnace Engineers, Inc., 1551 West Liberty Ave., Pittsburgh, Pa., has been given a six month's leave of absence at the request of the United States government who is using him now as a visiting expert over seas.

Obituaries

Harrison Wayne Fitzgerald, consultant for Armco International Corp., died March 9 in Hamburg, N. Y. Mr. Fitzgerald was born in Scotch Hill, Pa., on January 15, 1873. He was graduated as a teacher from Clarion Normal School and followed that profession for only a few years. He was with the Bethlehem Steel Co., the Lackawanna Steel Co., the Donner Steel Co., Freyn Engineering Co., United Engineering and Foundry Co., the Steel Company of Canada, Ltd., H. A. Brassert Co., A. J. Boynton Co., and then the Armco International Corp. He had been engaged as consultant with Freyn, United, Brassert, Boynton and Armco International. Prior to his consulting work, he had been active in the steel industry for three decades.

James R. Kelly, 71, formerly superintendent of open hearth plant, American Steel & Wire Co., Cleveland, Ohio, died March 14. After serving 24 years with the Wire Company, Mr. Kelly was transferred to the Carnegie-Illinois plant at Gary, Ind., taking charge of the open hearth plant there.

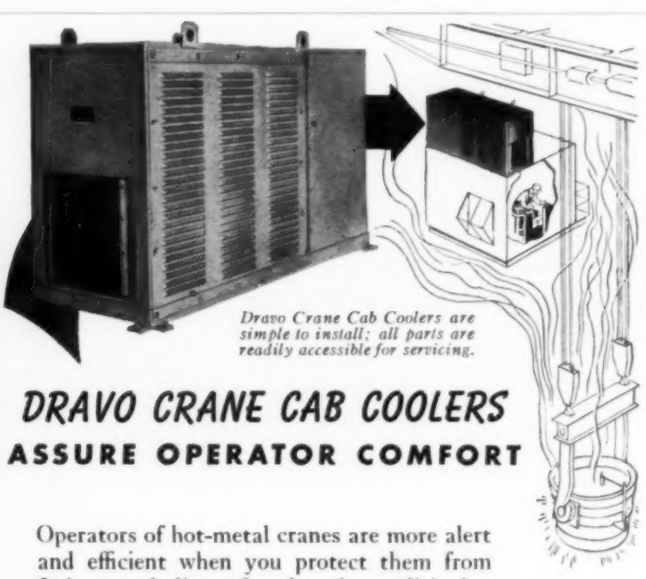


Ajax design permits installation vertically or horizontally. No lubrication.

Remember that all the horsepower goes through the coupling... put it up to Ajax.

AJAX FLEXIBLE COUPLINGS

AJAX FLEXIBLE COUPLING CO. INC.
20 English Street
WESTFIELD, NEW YORK



Dravo Crane Cab Coolers are simple to install; all parts are readily accessible for servicing.

DRAVO CRANE CAB COOLERS
ASSURE OPERATOR COMFORT

Operators of hot-metal cranes are more alert and efficient when you protect them from fatigue and discomfort by air conditioning the cabs with Dravo Crane Cab Coolers.

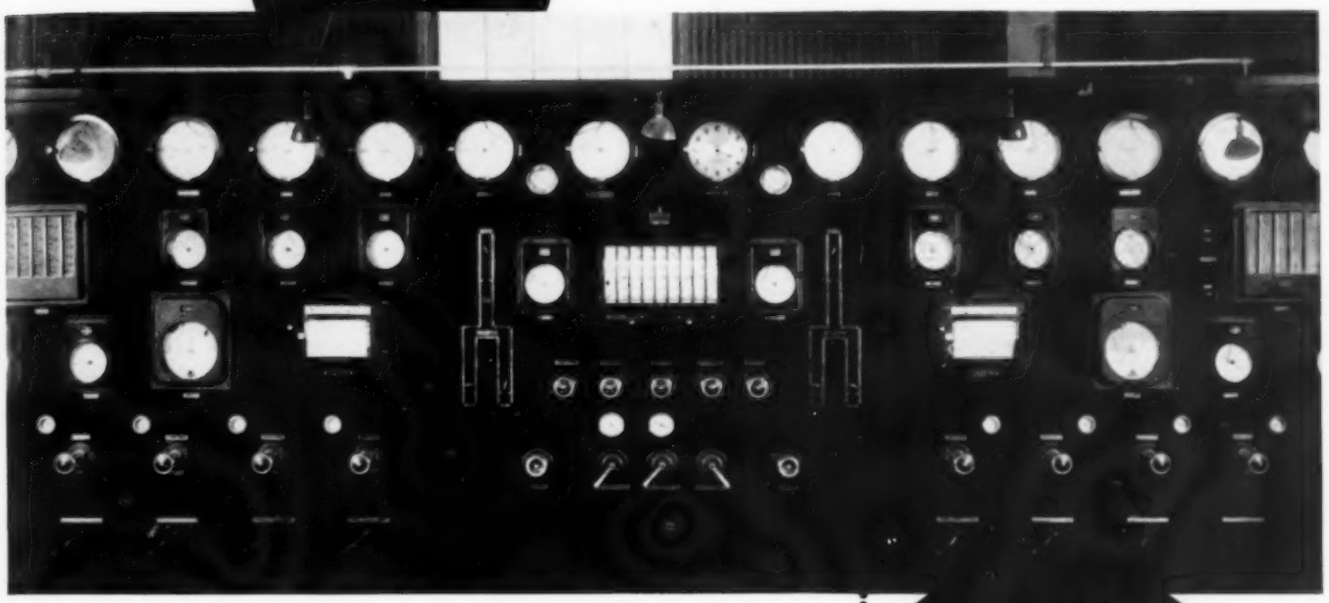
Completely self-contained, and requiring only an electrical connection, the Dravo Crane Cab Cooler provides complete air conditioning:

Cooling	Continuous Ventilation
Fume and Odor Removal	Dehumidifying
Dust Filtering	Winter Heating

DRAVO CORPORATION
PITTSBURGH • PHILADELPHIA • CLEVELAND • NEW YORK
CHICAGO • DETROIT • ATLANTA • BOSTON
Sales Representatives in Principal Cities

DRAVO

For *Efficient* Boiler Control



ASKANIA REGULATORS

insure precision operation

In ideal boiler control, three conditions must be accurately maintained:

1. Heat input must be constantly proportioned to heat output. (Balance is indicated by constant steam pressure.)
2. Correct ratio between fuel and combustion air must be maintained at all loads to produce a constant composition of waste gases. (Balance is indicated by fuel-air ratio.)
3. Waste gases must be withdrawn from the furnace at the rate at which they are formed. (Balance is indicated by furnace pressure.)

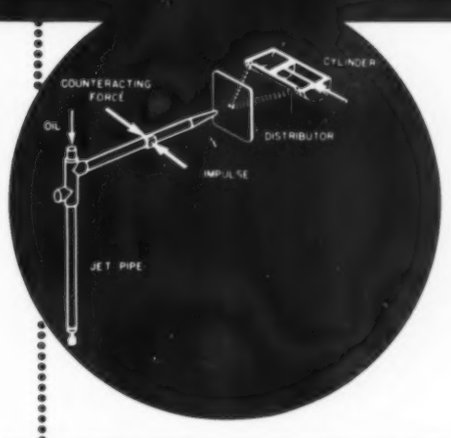
The efficient answer to these requirements for boiler control and other applications is met with Askania Regulators. Operated by the exclusive Askania Jet Pipe, these regulators provide automatic pressure, proportioning and load control to secure highest combustion efficiency. Performance records in many installations prove that Askania's sensitive, simple, sturdy controls solve the most complicated problems in the most efficient manner.

Send for full information on Askania Controls.

ASKANIA REGULATOR COMPANY

A Subsidiary of General Precision Equipment Corporation

240 EAST ONTARIO STREET **CHICAGO 11, ILLINOIS**



The Jet Pipe Principle

The Askania Jet Pipe amplifies a minute signal into a powerful movement of a hydraulic cylinder to operate control valves, dampers or other mechanisms.

The Jet Pipe swings freely on a hollow vertical bearing into which oil is supplied. As the oil leaves the nozzle of the Jet Pipe it strikes at two closely adjacent openings in a cylinder block. The Jet Pipe moves right or left with the slightest change of signal, allowing more or less oil to enter the right or left opening.

This, in turn, moves the piston to right or left producing proportional cylinder action. As soon as equilibrium is re-established the Jet Pipe returns to its neutral position and the piston stops.

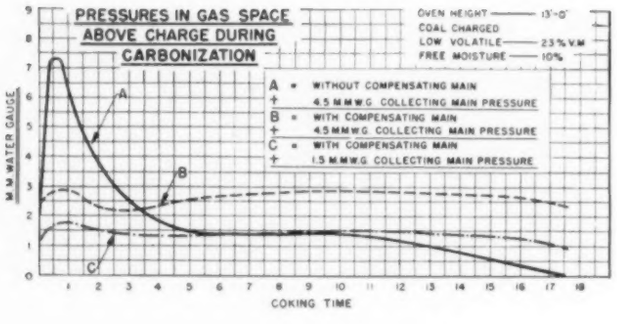
ASKANIA Controls

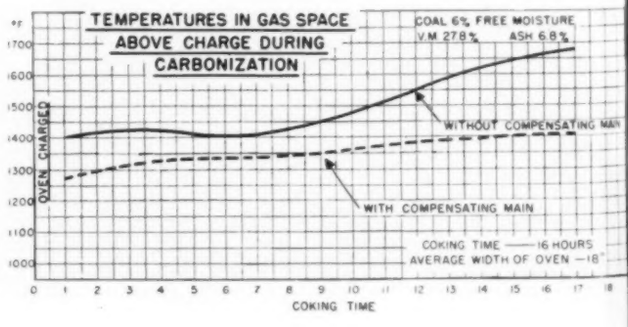
Double collecting main

with controlled

TWO collecting mains provide a free exit for the gas rapidly evolved as an oven is charged. Cool, moist gas, under an adjustable time cycle schedule, is recirculated across the tops of ovens nearing the end of the coking period. Peak oven pressures are avoided; top temperatures are controlled; and these benefits accrue:—

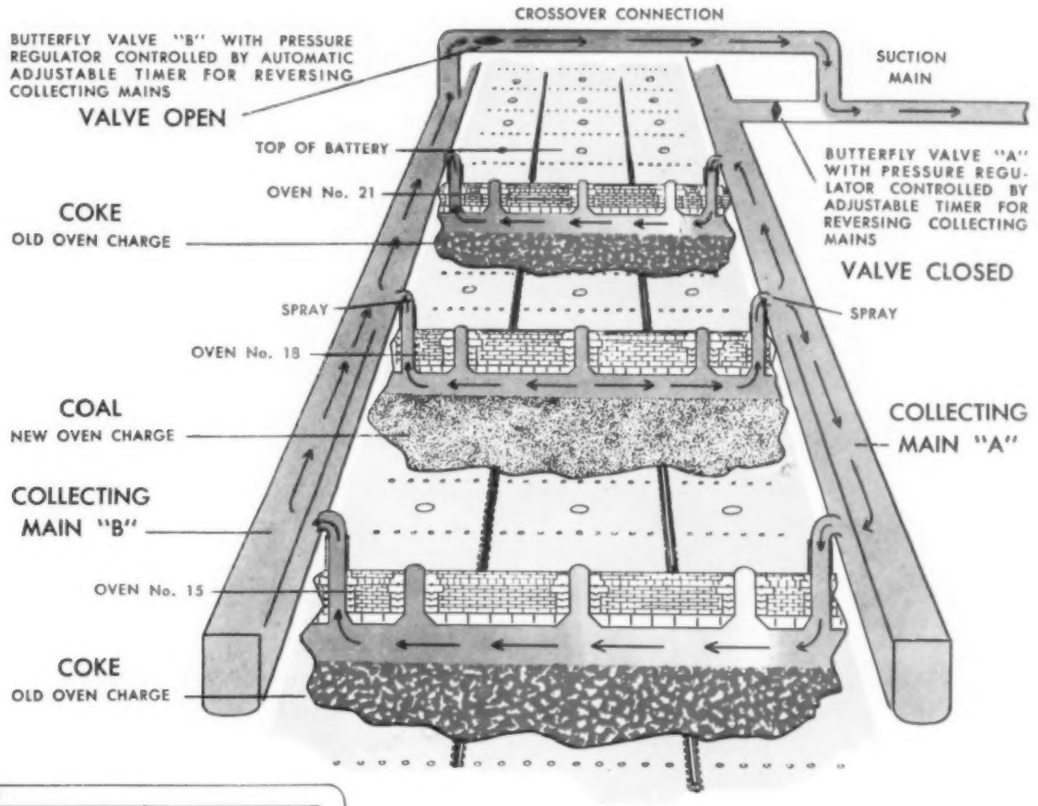
- *Roof carbon is eliminated* — together with its attendant troubles.
- *Coking capacity is increased* — without roof carbon there is no need to take one or more ovens "off the main" or to leave ovens empty — hence more ovens can be pushed per day on the same coking time.
- *Pressures between ovens and flues are balanced* — reducing to a minimum both the loss of gas and by-products to the chimney, and the dilution of gas with products of combustion.
- *Charging is smokeless* — without carbon on roof or on slopes of charging hole cutbacks the gas has an escape path, unobstructed in both directions along the top.
- *Charges are completely coked out* — no need for semi-coked tops.
- *"By-product tops" are maintained* — increasing yields of gas and by-products.

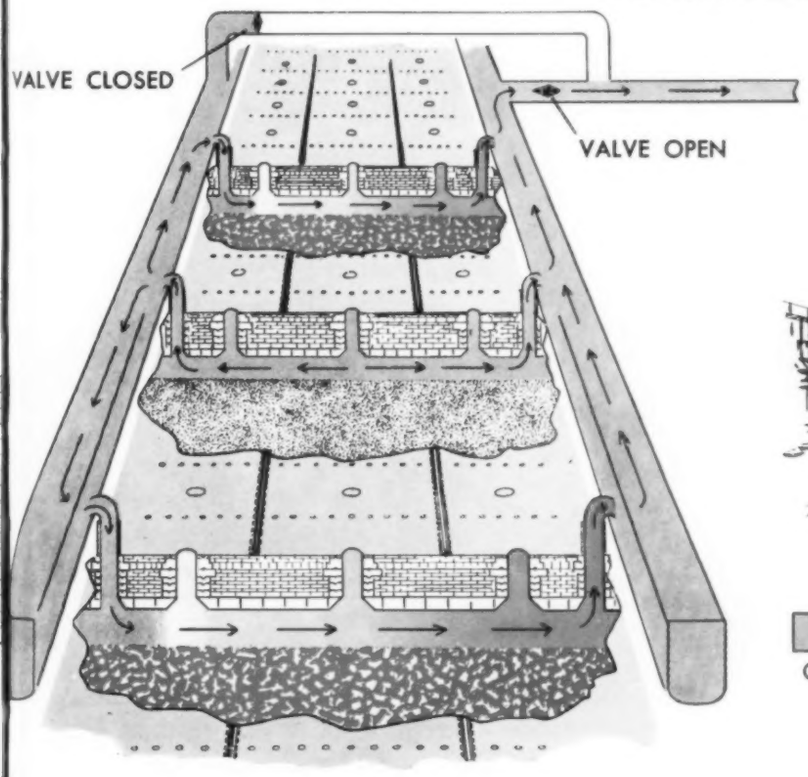

PRESSURES IN GAS SPACE
ABOVE CHARGE DURING
CARBONIZATION
OVEN HEIGHT —— 13'-0"
COAL CHARGED
LOW VOLATILE —— 23% V.M
FREE MOISTURE —— 10%
A = WITHOUT COMPENSATING MAIN
+ 4.5 M.M.W.G. COLLECTING MAIN PRESSURE
B = WITH COMPENSATING MAIN
+ 4.5 M.M.W.G. COLLECTING MAIN PRESSURE
C = WITH COMPENSATING MAIN
+ 1.5 M.M.W.G. COLLECTING MAIN PRESSURE
M.M. WATER GAUGE
COKING TIME

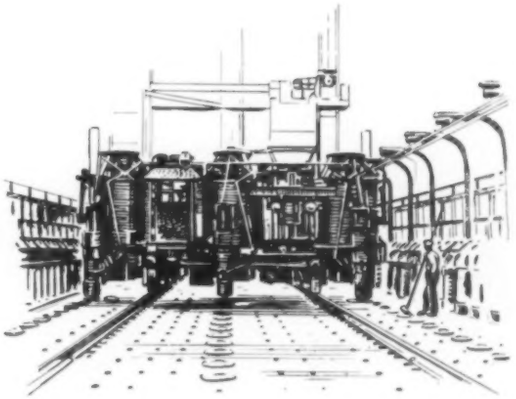


WILPUTTE

recirculation







COOL GAS

HOT GAS

COKE OVEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

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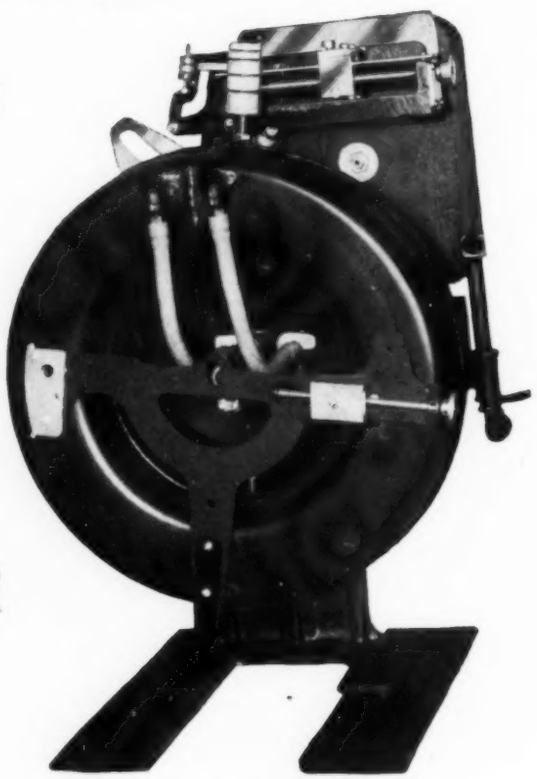
A differential of ½ inch of water gives full scale operation with this

HAGAN

Ring Balance

FLOW METER



MODEL 2256 WITH
R22 RING.

Steel mills frequently have the problem of measuring blast furnace, coke oven, or natural gas or air at very low pressures—and this Hagan Ring Balance Meter provides the answer. You can, if necessary, get *full scale operation* with a differential of only ½ inch of water—ample evidence of the sensitivity inherent in the Hagan Ring Balance design.

The low-differential meter shown here is a standard model in the Hagan Ring Balance line. Other standard models provide for differentials up to 480 inches, and static pressures up to 10,000 p.s.i. Pressure and temperature compensation may be added to any standard model, either with or without separate pressure and temperature records. Compensated flow may be automatically totalized by means of a simple and accurate integrator. Dual meters—also standard—record two flows on a single chart.

The Hagan Ring Balance Flow Meter is, by all odds, the most versatile flow meter in the world. For full information, just fill out and mail the coupon below. If you have any special metering problem, write us about it and we will be glad to tell you how this meter can contribute to its solution.

Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

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RING BALANCE FLOW AND PRESSURE INSTRUMENTS
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BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

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Pittsburgh 30, Pa.

Please send me Ring Balance Meter Bulletin 2M48.

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ISE-4

Publication Service...

(1) Surface and Face Grinders

A catalog on grinders is available to you. This catalog describes several types of surface, face and disc grinders. Included are descriptions of rotary surface grinders, which are popular for tool room grinding, die grinding and general production and manufacturing operations. Also described is a face grinder with a traveling table and hydraulic feed. This type of grinder is used in steel mills for face grinding of knives and shear blades and other items. Complete specifications and technical data on each type of grinder are included in this catalog. We recommend that all rolling mill and maintenance men concerned with grinding problems obtain this book for their study. (190). Hanchett Manufacturing Co.

(2) Motor Control

A complete catalog on motor control is available to you. This catalog includes descriptions of solenoid starters, overload relays, reversing switches, automatic starters, drum switches, pilot switches, controlling rheostats, resistance starters, solenoid relays, a-c current contactors, starting switches, push buttons and selector switches, oiltight control stations and units, limit switches, plugging and pressure switches, temperature controls, timing relays and multi-unit control centers. A section is devoted to the proper selection of correct heater elements. This is an excellent catalog and one that should be in the file of every person concerned with the purchase of electrical equipment. (Third edition). Allen-Bradley Co.

(3) Slag Handling

A brand new application in the handling of slag has been developed through the use of a diesel electric shovel. The use of this diesel electric shovel in slag pits and piles eliminates the need for power lines, which require heavy maintenance and replacement due to the heat contained in the slag. If you have been having a problem in your slag pit through the use of power lines, we recommend you send for the literature that is available to you on the application of a diesel electric shovel for this purpose. This shovel has already proven itself in slag pit installations. (Bulletin X83-DE). Harnischfeger Corp.

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(4) Armored Crane Wheels

Bulletins are available to you on armored crane track wheels which have longer wear, greater strength and shock resistance. These crane wheels will reduce maintenance costs and delays. The literature gives complete data and specifications on crane wheels. It tells how these crane wheels have just the right hardness in just the right places. If you are concerned with crane wheel replacements, we suggest you have this information in your file. Pittsburgh Gear Co.

(5) Automatic Switching

Two bulletins are available to you. The first bulletin is entitled, "Automatic Switching" and describes motor-operated air break switches, telling how they provide economical means for automatic restoration of service in event of line failures. This particular bulletin is very complete in detail and is in the form of a technical article. The second bulletin is entitled "Type MK-40 Switches." The bulletin covers a vertical break, rotating insulator type switch embodying features which make it ideal for handling the heavily loaded circuits prevalent in present day power systems. We recommend these bulletins for your study. (4811 and 4807). Delta-Star Electric Co.

(6) Blast Furnace Stove Burner

A bulletin is available describing a blast furnace stove burner which assures ideal burner combustion conditions in the stove burner through automatic proportioning of air and gas at a predetermined ratio. The bulletin describes the arrangement, construction, capacity, operation, air flow and combustion control. A section is devoted to the accessories provided with the burner. Schematic diagrams, showing internal operation of the burner, are included as well as photographs. Bloom Engineering Co.

(7) Mill Operator's Pulpits

A bulletin is available describing a modern streamlined, air conditioned mill operator's pulpit. These modern pulpits offer many advantages, resulting in the improvement of mill production and better personnel relations. This pulpit was actually born in the steel mill because it was developed from the ideas of steel men who wanted something better and more efficient. It was designed and built to conform with their specifications. Also included is a description of standard portable mill offices, grease houses and utility buildings. Lee Wilson Construction Co.

(8) Dust Handling

A bulletin is available describing an automatic filter specifically designed for both average ventilation and air conditioning and heavy duty industrial service where large volumes of air are to be filtered. This catalog contains capacity and dimension tables, cutaway drawings, and illustrations and suggested specifications. If you have a dust handling problem, we suggest you send for this bulletin. (Model A-3). Dollinger Corp.

(9) Cinder Cars

A bulletin is available on electrically operated, double pot cars, air or steam operated single pot

cars. This bulletin describes the cars and shows both types of cars in shipping and dumping operations. William B. Pollock Co.

(10) Open Hearth Furnace Reversal Systems

A bulletin is available announcing the Bloom time cycle reversal system for open hearth furnaces. It describes how this completely self-contained unit can independently set the firing period for each end of the furnace by means of timing devices on the front of the cabinet. It also tells how these firing periods can be readily changed when desired. With this new system, it has been found that the average furnace can be completely reversed in 9 to 10 seconds. According to the company, smooth reversals have been accomplished in even shorter time. Savings in fuel and increased production are two accomplishments claimed for this system. (4100). Bloom Engineering Co., Inc.

(11) Split Second Variable Speeds

Bulletins are available describing a new 5 hp model of a revolutionary speed control having unlimited ratios. These "Speed Selectors" have been manufactured for several years in ½, 1 and 2 horsepower units and are widely used in many industries throughout the United States. This variable speed drive utilizes an entirely new principle of planetary motion applied to speed changers in combination with standard V-belts and variable pitch sheaves, making possible infinite ratio, split-second control of speeds from 0 to 800 rpm and into reverse where needed. The wide range of speeds provided by Speed Selector increases machine versatility and efficiency. Its unusual design eliminates gear shifts, clutches, multi-speed motors, step pulleys and other complicated devices. Speed Selector, Inc.

(12) Clean Oil Engineering

A set of four two-color booklets gives the complete story on the value of filtering oils and coolants. The four booklets discuss: 1. The tremendous dollar savings in man hours, lower operating costs and higher production. 2. How to solve problems of dermatitis, excessive rejects, coolant disposal, machine downtime. 3. How to do it — the right method and equipment to handle any problem from 1 to 500 machine tools. Honan-Crane Corp.

(13) Molded Bearings

A folder is available describing a new product called "Lignalloy molded bearings." The folder tells how these bearings, properly applied in your mills, will pay you in lower lubricant, maintenance, power and bearing costs, and at the same time increase your production. Intermediate, block, and radial types are discussed and illustrated. Included are the physical qualities of the molded bearing. Kling Brothers Engineering Works.

(14) Distribution Transformer

The new "Pole Star" catalog presents the story of an entirely new distribution transformer. It's the story of a transformer that features a core wound of cold rolled steel, which has an inherent low exciting current. It's also the story of a new streamlined transformer, lighter in weight, and smaller in dimensions than its prewar predecessor. The catalog shows how the transformer is constructed from beginning to end. This includes detailed information on coils, core, core frames, lead assembly, tank, bushings, final assembly, mounting, crating and shipping. It also includes valuable mechanical data as well as outline drawings. (349). Pennsylvania Transformer Co.

(15) "Vari-Pitch" Speed Changers

"Vari-Pitch" speed changers for increased production and greater machine versatility are described in a new 12-page bulletin just released. The bulletin points to operating advantages of the changers — they save power, space and time — shows why they are easy to inspect and maintain, and portrays typical installations. Included in the bulletin are data on speed range, a selection table of recommended unit size for standard motors, general dimensions of pilot motor arrangements and arrangement diagrams. (20B6013-C). Allis-Chalmers Mfg. Co.

(16) Gas Burner Catalog

A 130-page new industrial gas burner catalog describing high and low pressure equipment for all common gaseous fuels has just been published. Divided into 10 sections, the attractively maroon-bound catalog is designed as a ready reference source for all engineers concerned with the specification and design of gas combustion equipment. In addition to presenting the more than 60 types of burners in 600 sizes, the catalog contains much practical data as to the selection of burners for most industrial heating services with the various gaseous fuels. A useful engineering data section on furnace design and heat input requirement calculations has also been included. The wealth of burner information contained in this catalog should be easily accessible to all men who select and design combustion equipment. Surface Combustion Corp.

(17) Speed Reducer Bulletin

A new, 44-page bulletin just issued, contains complete information about the company's line of speed reducers which are now offered in a wider range of sizes and capacities. The new bulletin gives simple, easy-to-understand directions for selecting speed reducers of the horsepower and speed required, and will be of interest and practical value to engineers responsible for the selection, operation, and maintenance of power transmission units. Contents include complete descriptions of units of the single and double reduction types, specifications, horsepower rating tables, overhung load capacities, dimensions and weights. (449). Farrel-Birmingham Co., Inc.

(18) Sheet Edge Control

Designed to provide automatic guiding and positioning of sheet materials in high-speed web and strip processing, a new, integrally designed electronic control device, the "VSP Camber (Edge) Control" — is reviewed in a two-page bulletin just issued. This new unit, combining electronic elements with a rotating element, permits continuous operation while accurately positioning strip at speeds as high as 3000 fpm. Already used on slitting, side-trimming and shearing lines in the steel industry and on winder reels of paper processing drives, the VSP is also said to be adaptable to applications un-

limited in number where a position guiding control is desired.

In addition to describing this equipment, its construction and operating features, the bulletin includes schematic wiring diagram and pictures of typical installation. (K-2051). Reliance Electric & Engineering Co.

(19) Automatic Oilers

A bulletin is available that features an entirely new principle of visible, automatic lubrication for solid, wick and waste-packed bearings. Has removable wick retainer and variable feed control. Easily adjusted to feed filtered oil or liquids as thin as water or as heavy as molasses. Trico Fuse Manufacturing Co.

(20) Multi-Pointer Gages

Latest developments in "Bailey Multi-Pointer Gages" are described in a new bulletin which is now being distributed. Use of the diaphragm operated unit for measurement of pressure, draft or differential is explained in detail and some of the many standard ranges available are listed. Described in detail are four styles of casings, all of which are available in sizes to accommodate from one to twelve units. Data includes net and shipping weights plus complete dimensions of casings. The bulletin has numerous illustrations including photographs, diagrammatic drawings, and cut-away drawings. (163-B). Bailey Meter Co.

(21) Mounted Wheels and Points

The versatility of mounted wheels and points for offhand and precision work and for grinding in hard to reach places is described in a new folder. Available in handy file size form, the folder shows full size illustrations of these products together with suggested uses and a graphic presentation of the wide range of sizes available. Also included is information on grains, grades, operating speeds and a section giving four easily followed rules for ordering the desired wheels and points. (ESA-67). Simonds Abrasive Co.

(22) Resistors

A resistor bulletin is available on "Tab-Weld" sections for heavy electric current circuits shows sizes, total ohms and resistance-values between tap-plates. These resistors stamped in plate form have ends off-set, so that the mated off-set ends are welded to form a continuous path throughout each section. (942). Electric Controller & Manufacturing Co.

(23) Plastic Fire Brick

"Here's Longer Life For Your Furnace Linings" is the caption of a newly published bulletin on plastic fire brick, the modern monolithic refractory. Walsh Refractories Corp.

(24) Use of Electrical Diagrams

A revised bulletin, entitled: "The Purpose and Use of Electrical Diagrams Supplied with G-E Switchgear Equipment," is available to you. (GET-1293A). General Electric Co.

(25) Hydrostatic Precipitation

A bulletin is available that tells about the "Type N Roto-Clone," used for the collection and control of dust generated in manufacturing and process operations, which has been re-designed to permit wider application and improved performance. Developed in 1942, the Type N Roto-Clone is a hydrostatic precipitator that cleans the air by the combined action of centrifugal force and a thorough inter-mixing of water and dust-laden air, reusing the water without recirculation pumps or spray nozzles. The new design, with capacities through 48,000 cfm maintains a lower pressure drop with the same cleaning efficiency and water recirculation rate and can be operated from 50 to 120 per cent of its nominal rating without affecting its collecting efficiency. All sizes are available in either manual clean-out, sludge ejector or hopper bottom arrangement. (277-A). American Air Filter Co., Inc.

(26) Industrial Waste Disposal

Publication is announced of a bulletin entitled, "Industrial Waste Disposal." The bulletin describes the application of automatic pH recording and controlling instruments and recording flowmeters to industrial waste disposal operations. Photographs of the instruments and diagrams of several typical waste disposal applications are included. (138) Bristol Co.

(27) 30-Ton Diesel Locomotive Cranes

A new catalog, covering 30 ton diesel locomotive crane, has just been published. The 20-page catalog contains illustrations of the crane in different types of work. Many mechanical illustrations are also included. (600-L-6). American Hoist & Derrick Co.

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IRON & STEEL ENGINEER

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IRON & STEEL ENGINEER

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PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ALLIS-CHALMERS MANUFACTURING CO.		Reprints of advertisements describing Allis-Chalmers ore beneficiation equipment.
51	BABCOCK AND WILCOX CO.	BULLETIN R-22	Handy reference booklet summarizing significant data and application information for a wide range of refractory materials.
52	BAILEY METER CO.	BULLETIN 17	Describes how bailey units control flow, level, speed, pressure, temperature, gas analysis, ph, conductivity, etc.
53	BEDFORD FOUNDRY AND MACHINE CO.		Catalog on electric overhead traveling cranes.
54	BLOOM ENGINEERING CO.		Bulletin describing the Bloom tempered flame burner.
55	BROWNING AND CO., INC., VICTOR R.	BULLETIN S	Describes mill type cranes.
56	BUFFALO FORGE CO.	BULLETIN 2424E	Contains up-to-date developments and engineering facts on low-cost fume removal for better production.
57	CARDOX CORP.	BULLETIN 449	Describes the use of low pressure carbon dioxide to provide fire protection for steel plants.
58	CLEVELAND WORM AND GEAR CO.	CATALOG 300	Shows how to quickly figure proper size speed reducers for your equipment.
59	CRANE CO.	CRANE CATALOG, PAGE 304	Describes No. 47XR 150-lb cast steel wedge gate valves, designed for tight seating with long-lasting excelloy to nickel alloy.
60	COLUMBIA ELECTRIC MFG. CO.	CATALOG IS-700	Motor generators for electroplating, anodizing, electro-cleaning, and electro-polishing.
61	CROUSE-HINDS CO.	SECTION 25, CATALOG 2500	Complete listings of vapor-tight, industrial lighting condulets for use in boiler rooms, power houses, and all indoor and outdoor locations.
62	CUNNINGHAM CO., M. E.		Complete data on safety steel stamps.
63	DELTA-STAR ELECTRIC CO.		Literature on disconnecting switches, interrupter switches, crane rail supports and many other electrical items.
64	DURABLA MANUFACTURING CO.	BULLETIN 9S4	Describes a patented arch construction valve member that gives constant pressure-proof seal.
65	ELECTRIC SERVICE MANUFACTURING CO.		300-page catalog containing details on a complete line of insulators, collectors, and rail shoes.
66	GENERAL ELECTRIC CO.		Catalog on Deltabeston magnet wires.
67	GENERAL ELECTRIC CO.	BULLETIN GEA 4654	Technical data on the AISE MD-600 mill motor.
68	HAGAN CORP.	BULLETIN 2M48	Describes the ring balance flow meter for measuring gas or air at low pressures.
69	I-T-E CIRCUIT BREAKER CO.	CATALOG 2202	Complete details on the Type MT air circuit breaker (including automatic reclosing applications).
70	JOHNS-MANVILLE CORP.		Handy packing selector for reciprocating and centrifugal pumps.
71	KLING BROTHERS ENGINEERING WORKS.	BULLETIN 245	Specific facts and specifications on rotary shears.
72	LEEDS AND NORTHRUP CO.		Catalogs on L&N integrated temperature-pressure-combustion control for large furnaces.
73	LUMNITE DIVISION, UNIVERSAL ATLAS CEMENT CO.		Booklet describing the use of Lumnite refractory concrete in open hearth flues. Also a manual on refractory concrete.
74	MARVEL ENGINEERING CO.	CATALOG 103	Tells how to arrest unclean oil with hydraulic synclinal filters.
75	NATIONAL-ERIE CORP.	BULLETIN 9	Describes alloy gear steels for use on drives for billet shears, high speed presses, overhead traveling cranes, power, power shovels, etc.
76	OKONITE CO.	RESEARCH BULLETIN IS-101	Gives research on what goes into an Okonite cable, what tests it must pass, what care is taken to control its electrical characteristics, and other data.
77	PENNSYLVANIA TRANSFORMER CO.	BOOKLET 1492	Standard parts power transformers.
78	POLLOCK CO., WILLIAM B.		Literature describing blast furnace shells, stoves, dust catchers, washers, piping, skip bridges, platforms, cast houses, bells, hoppers, and miscellaneous valves.
79	POOLE FOUNDRY AND MACHINE CO.		Catalog giving full description and engineering data on flexible couplings.
80	PYLE-NATIONAL CO.	CATALOG 1100	Complete listings on explosion proof "Pylets" for hazardous locations.
81	SPEER CARBON CO.		Carbon brush data sheet.
82	SQUARE D CO.	BULLETIN 7954	Dynamic lowering hoist control panel.
83	WAGNER ELECTRIC CORP.	BULLETIN MU-185	Information on a complete line of electric motors.
84	WALDRON CORP., JOHN		Catalog on improved gear type couplings.
85	WARE FUSE CORP.		Catalog on "Hi-Lag" renewable fuses that have only 3 parts to handle to replace blown link.
86	WING MANUFACTURING CO., L. J.		Descriptive bulletin on revolving unit heaters.
87	YOUNGSTOWN WELDING AND ENGINEERING CO.		Descriptive literature on mechanical picklers for coils, tubing and sheets.

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IRON & STEEL ENGINEER

1011 EMPIRE BUILDING

PITTSBURGH 22, PA.

Whitcomb 50-ton Diesel electric locomotive designed specifically for steel mill operations, one of six identical Whitcombs now in service at this leading steel plant.

Fueling an 80-ton Diesel electric locomotive at an eastern steel plant. Fuel economy is an important advantage of Whitcomb Diesels, along with high availability, low maintenance costs.

At Scullin Steel, a 50-ton Whitcomb Diesel locomotive delivers inbound cars of scrap and materials to the 100-acre plant of Scullin Steel Company, St. Louis, Mo.

Whitcomb 35-ton Diesel electric locomotive, narrow gauge, in operation at the Ohio Works (Youngstown) of the Carnegie-Illinois Steel Corporation. One of four Whitcomb Industrial Diesels operating here.

Whitcomb Industrial Diesels Tailor-Made For Steel Mills

Newest type Whitcomb Industrial Diesels include many special features designed to provide increased efficiency, easier operation, lowered hauling and switching costs.

Typical refinements include greater visibility through scientific window arrangement, a spacious, draft-free cab. Batteries are located at the sides for easy access and servicing. Bulk heads between engines and generators protect the latter from excessive engine heat. Safety step wells provide extra protection for switchmen.

As a first step toward cutting your haulage and switching costs, write today for complete information on the Whitcomb Industrial Diesel line — Diesel electrics from 25 to 95 tons; Diesel mechanicals from 3 to 30 tons.

Most any switching or hauling assignment is easy for this powerful 80-ton Whitcomb Diesel locomotive in its steel making job. Compact, mobile, low-cost power speeds production.

There is no power cheaper than Diesel; no locomotive finer than a Whitcomb.

BLW THE BALDWIN GROUP

THE WHITCOMB LOCOMOTIVE CO.

ROCHELLE, ILLINOIS

Subsidiary of

THE BALDWIN LOCOMOTIVE WORKS

15-TON SCARFING BUILDING CRANE

BUILT BY MORGAN Engineering

Illustrated is a Morgan 15-ton, 3-motor, 40′-0″ Span Half Gantry Type Scarfing Building Crane. Hoist is actuated through a worm reduction unit for operating a counterweighted hoist rack connected to two lifting magnets, for handling slabs.

THE MORGAN ENGINEERING CO.

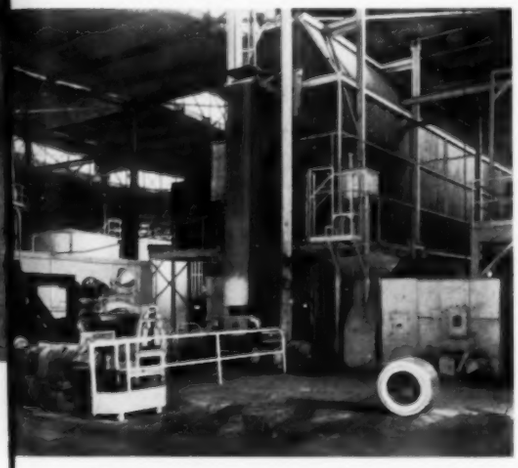
ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Equipment News...

MODERN STEEL MILL PICKLING METHODS MAKE PICKLE HOUSE MUCH SAFER

▲ Pickling, or the removal of scale in dilute acid solutions, has been practiced in industry for many years, antedating inhibitors, the use of which is of comparatively recent origin. That inhibitors have saved vast amounts of both acid and metal is axiomatic in industries throughout the world, but what has not been so obvious are the improved working conditions for the pickling gang. In the twenties, "Rodine"* selective inhibitors, or pickling acid controls, introduced improved pickling technique. Whereas oldtime picklers depended on haphazard formulas and practices that were often as incorrect as they were mysterious, the trend of today is towards the maximum possible savings in acid, metal and labor.



Continuous strip pickling prior to electrolytic tinning in large Eastern steel plant. "Rodine" is highly effective in preventing over-pickling and burning, especially when the strip remains in the acid during shutdowns.

The pickle house of today is a far cry from the sloppy, unsafe plant of yesteryear. A brief description of a recently installed unit will indicate the progress that has taken place in the last twenty years. In this plant the pickling and washing tanks are constructed in plastic, as are the fume exhausting fans, while fume extraction is carried out by means of the Kestner lip type system. Fume exhaustion from the lip of the tank not only provides ready access from above, thus allowing an overhead crane to be used, but is superior to an exhaust in the roof in that no fumes pass through the building. The entire plant is laid on a blue brick foundation so designed that all the acid, water, etc., collects at a central point and there cannot be any build-up of acid at any one place.

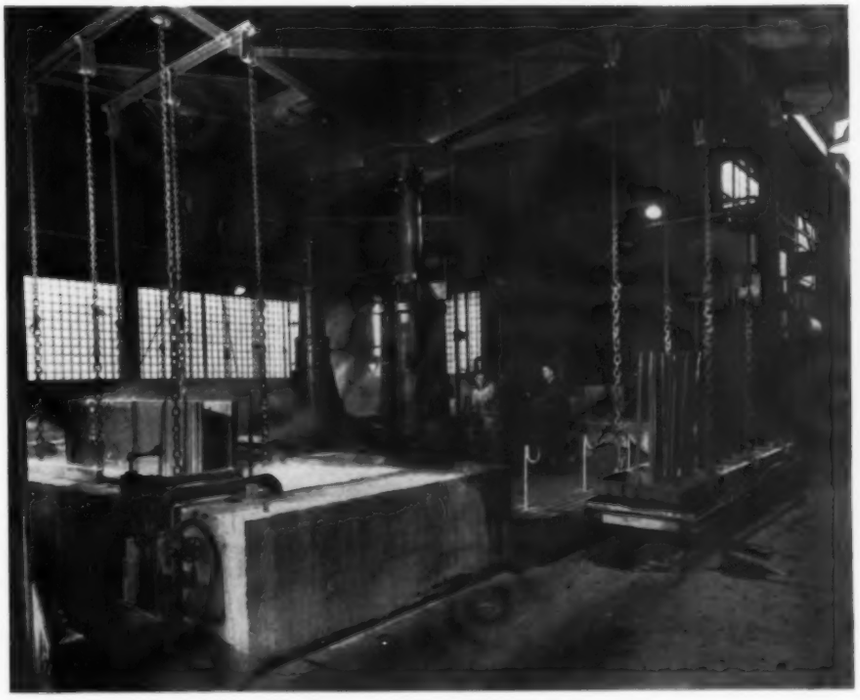
Today's pickling house is a production line. In a typical installation, acid, rinse, lime tanks and bakers are set in a line past which an electric crane travels with its cab, usually near the floor so the operator may better view the work. This not only makes possible the rapid, efficient and economical handling of large tonnages but, with leak-proof tanks, a source of waste and mess is eliminated. With controlled temperatures and selective inhibitors, the pickling supervisor has reasonable assurance pickling will be completed in the allotted time in baths the composition of which he now knows.

The gross savings made with "Rodine" include the saving in metal, plus the saving in acid, plus the saving in labor, plus the substantial savings in rejections due to various causes. Since appreciable amounts of both metal and acid are saved, baths containing it can be operated longer and they can be kept at a desired concentration with less replenishments of acid.

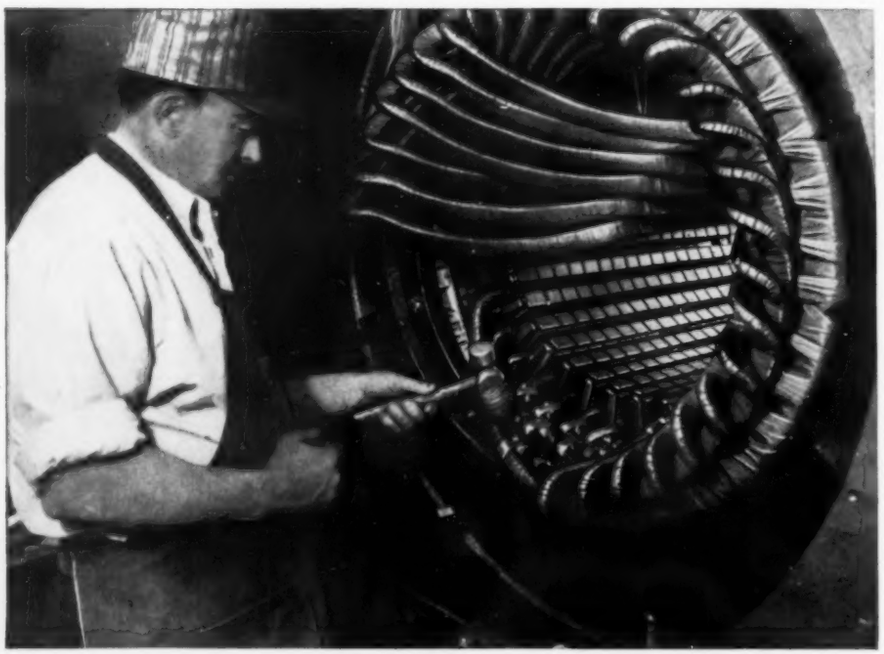
ROLL NECK SEAL FOR STEEL MILL USE

▲ A new seal designed specifically for the rugged conditions met in the rolling of steel has been designed by the Crane Packing Co. This development, known as the "John Crane" roll-neck seal, resulted from years of investigation of the problems encountered in sealing steel mill roll necks, and has been proven in certain

Sheet pickler in large Eastern steel plant. Sheets are uniformly pickled and hydrogen embrittlement is minimized in acid inhibited with "Rodine." Note that fuming is largely eliminated.



to help you beat motor heat!



When overwork and ambient heat keep motor temperatures up, burnouts can be a constant threat to operation. To prevent frequent motor overhaul, insist on Deltabeston* magnet wire for every winding job.

Deltabeston is built in types for all high-temperature conditions up to 200 C. Insulated with purified asbestos, Deltabeston magnet wires are flexible for easy winding—heat- and moisture-resistant for long service. Whether you do your own rewinding or send it to an outside shop, always specify Deltabeston to beat motor heat.

To help you select

Now, to help you select the proper magnet wires for your heat problem, an informative 20-page booklet—with handy selector chart—is ready for mailing. Just fill out the coupon for your free copy.

**Trade-mark Reg. U.S. Pat. Off.*

DELTABESTON
Wires and Cables
built to
beat the heat

General Electric Company
Section Y9-446, Bridgeport 2, Connecticut

Please send me the new, free booklet on Deltabeston magnet wires.

Name ..... Title .....

Company .....

Address .....

City ..... Zone ..... State .....

GENERAL ELECTRIC

actual mill installations during the past two years.

The new roll-neck seal seals in the vertical plane, and maintains a positive drive at all times. It is a self-contained unit, flexible enough to take care of neck deflection. Multiple spring arrangement provides for endwise movement of the roll so that the seal does not have to take the mill thrust load. Once installed, the unit practically eliminates all maintenance.

Outstanding advantages of this end-face sealing development, as listed by the manufacturer are: increased bearing life with savings of oil and grease; ease of assembly—the entire unit just slides into place; compensation for shock, end play and neck deflection; elimination of wear and scuffing on neck or sleeve; lapped sealing faces which keep water out and lubricant in; lubrication of sealing faces to insure minimum friction and effect power savings; elimination of leakage which stains strip; all parts in oil, to eliminate corrosion and insure cool running of the seal; positive sealing under most severe operating conditions.

Construction of the "John Crane" roll-neck seal is shown in the cutaway drawing. An oil proof rubber floating seat ring (A) prevents leakage between the seat and the neck or thrust collar. A cast iron floating seat (B) provides a lapped sealing sur-

The new roll-neck seals in the vertical plane and maintains positive drive.

EXTRACTING OXYGEN FROM THE AIR

BY THE CUBIC FOOT

BY THE TON

Assures Your Supply - at low cost

There is an inexhaustible supply of oxygen in the air and the illustration above shows how one of the world's largest steel plants is equipped to extract oxygen, as needed, by the use of Air Products oxygen generators. This is just one of many similar installations of such varying monthly capacities as 25 million cubic feet, 10 million cubic feet, 7 million cubic feet and on down to as low as 200,000 cubic feet.

Greater security—complete freedom from delivery failures—results from making your own oxygen with leased Air Products generators. Your oxygen flows from the generator to your pipe line without handling. You eliminate the expense of handling, delivery, evaporation loss and residual loss, which add up to a large part of the total cost of oxygen. If you use 200,000 cubic feet or more of pure oxygen per month, let us figure with you for a more dependable and much less costly source of supply.

Air Products generators are simple and easy to operate. Observe in the illustration that one man is operating four large generators.

TONNAGE OXYGEN

AIR PRODUCTS also manufacture large capacity generators for the production of lower-purity oxygen in vast tonnage quantities for metallurgical and chemical purposes. These generators range in capacity from 1,000 tons to 40 tons per day. We invite inquiries for this type of equipment.

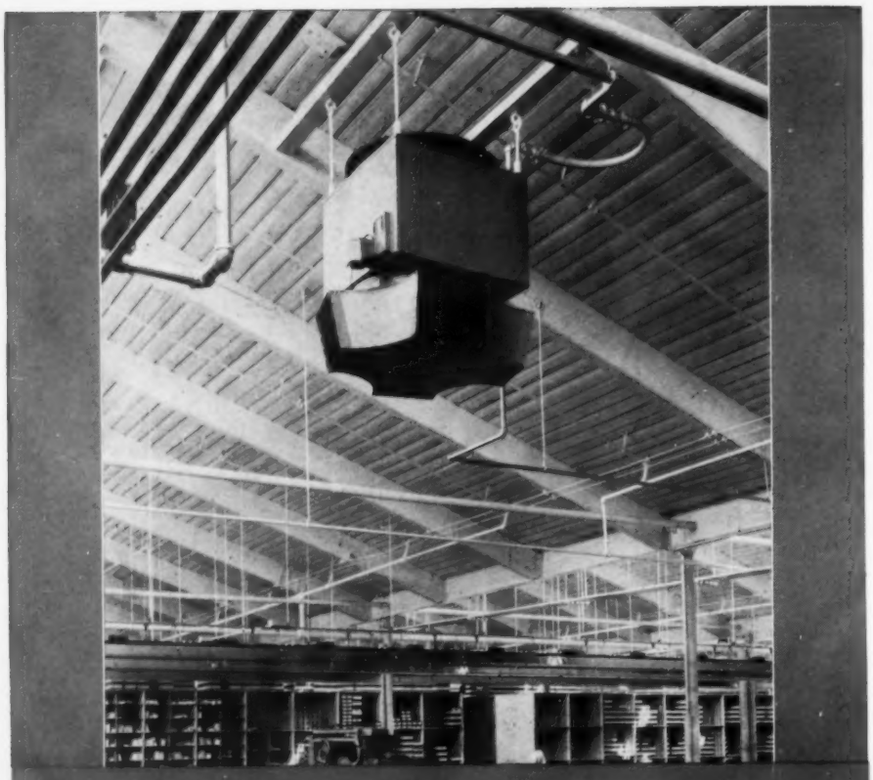
Assure Your Supply at low cost with

Air Products

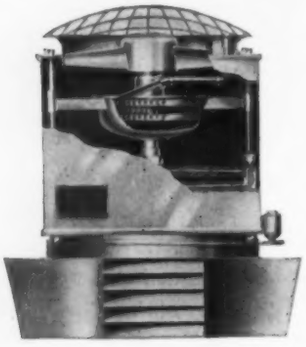
OXYGEN GENERATORS

AIR PRODUCTS, INC.

P. O. Box 538 Allentown, Pa.



Wing Turbine Driven Heater uses exhaust from fan turbine for heating



Where live steam of any pressure is available, it is possible to heat a plant advantageously by installing Wing Turbine Revolving Unit Heaters. The fan is driven by a Wing Turbine and the turbine exhaust is piped into the heater section. Electric motor and electric power are eliminated as the source of power (steam) is also the source of heat. The revolving discharge outlet distributes the heat to the working level, flowing around obstructions and to remote corners. Workers are pleased with the sensation of fresh, live, invigorating warmth. Write for descriptive bulletin or specific details.

L. J. Wing Mfg. Co. 142 W. 14th Street, New York 11, N.Y.

Factories: Newark, N. J. and Montreal, Canada

Wing

Revolving UNIT HEATERS

face against which the washer rides. This sturdy, precision lapped composition washer (D) forms one of the sealing faces and supports the "O" ring (E). The "O" ring is of oil proof synthetic rubber and forms a seal between the washer and bore. An inner steel spring holder (F) maintains proper location of the "O" ring and locates multiple springs (G) which compensate for wear and end play. The outer steel spring holder (H) guides the multiple springs and functions so as to maintain the seal as a unit. The cap screw and driving lug (I) prevents rotation of the washer and helps maintain the seal as a unit.

The seal is manufactured in sizes from 3 in. to 36 in., or larger where required by steel mill operations.

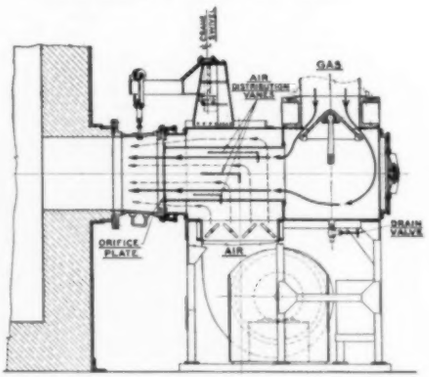
BLOOM ACQUIRES PATENTS ON STOVE BURNER

▲ The Bloom Engineering Co., Inc., announces that it has acquired all patents and manufacturing rights to the Paulsen-Steinbart blast furnace stove burner.

Several new features have been incorporated into the original design that have improved the operation of the burner and provided more compact arrangements. The new burner will hereafter be named the Bloom-Paulsen-Steinbart blast furnace stove burner.

The new design provides an ideal combustion pattern by completely surrounding the gas stream with a uniform air stream that not only assures proper combustion but also prevents the too often experienced gas leakage condition at the stove nozzle. A patented design for air vanes directs the air flow into a uni-

Burners of this type are used on the stoves for the blast furnace that now holds the world's record.



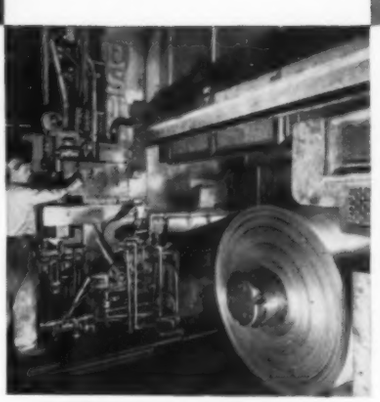
Torrington Bearings help

set production records

on World's Fastest Steel Rolling Mill

The Mesta-Built tandem cold strip mill, record setter for JONES & LAUGHLIN, is equipped with dependable Torrington 4-row Tapered Roller Bearings on work rolls to handle tremendous loads at high speed.

Mill Screw Downs, the fastest in response action ever installed in any five-stand tandem cold strip mill, put the pressure on back-up rolls through high-capacity, low-friction Torrington Thrust Bearings.



Torrington Radial and single and double-row Tapered Roller Bearings in the tension reel provide rigid support and smooth operation for coiling steel strip at high speeds.

More than 6,250 feet of steel strip a minute! That's the record set by the new tandem cold strip mill, the world's fastest, designed, built and erected for Jones & Laughlin by Mesta Machine Company.

To the work rolls, screw downs and take-up reel, Torrington Bearings—tapered, radial and thrust types—bring speedy response, greater rigidity and exceptional service life. They help keep the mill on the go with less maintenance attention.

If you want to set new production records, specify Torrington Bearings for your heavy-duty equipment. For engineering service from design to maintenance, contact our nearest office.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District Offices and Distributors in Principal Cities

TORRINGTON TAPERED ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Rollers

form stream and allows for a more compact arrangement of the burner and auxiliary equipment.

Correct gas/air ratio is maintained by a standard power-operated ratio regulator that balances the differential pressure drops of the gas and air streams across a gas/air orifice at the front of the burner. By this method the correct ratio is held constant regardless of the firing rate or the change in back pressure in the stove.

The performance of the Paulsen-Steinbart burners installed on the stoves serving the record-making H Furnace at the Sparrows Point plant of the Bethlehem Steel Co. has led to the new design.

The tests run on these 35,000 cfm blast furnace gas burners showed the advantage of this type of design and the necessity of correct air distribution. The patented air vanes that distribute the air uniformly make this new type of design adaptable for both new installation and a compact arrangement for the replacement of old installations.

The burner is available in three sizes with a maximum capacity of 15,000, 25,000, and 35,000 cfm gas. The operating capacity can be set at any value from 30 to 100 per cent of the maximum capacity. The operating range is from 5 to 100 per cent of the operating capacity.

DIESEL UNIT ELIMINATES POWER LINES IN SLAG PITS

▲ Have you checked the operating costs of your slag pit lately?

How would you like to eliminate the high operating costs of old equipment or the need for a power line, the original cost of which is about $6000 per mile, say nothing of the added costs involved in plug in stations, switch gear, etc.

With the new Harnischfeger P & H diesel electric shovel you can also eliminate the tail cable (cost about $2 per foot) and the upkeep and frequent replacement caused by damaging friction and heat. And there is no cable reel to buy—another saving of from $8000 to $10,000 or the time and expense of dragging tail cable around.

This new self-sufficient shovel has more digging power at the tooth point, and it also has more flexibility of movement from one pit to another, it spends more time actually digging.

These units are now being used in steel plant slag piles to replace power lines that needed frequent replacement.

ACTIVATED FUEL OIL GIVES CLEAN LINES

▲ For the more effective atomization, and greater Btu release of any grade of fuel oil, a product known as "Dacarol A" has been developed by

For Economical Material Handling

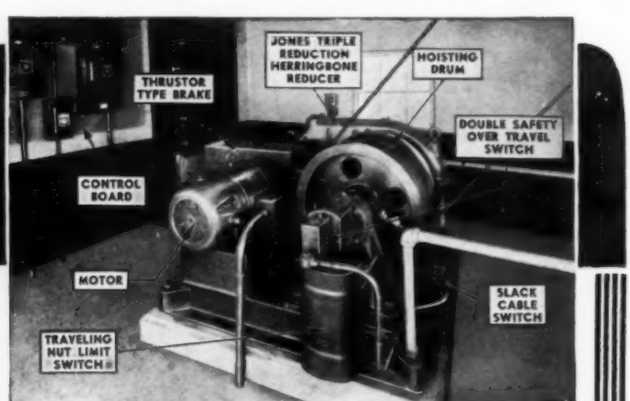
JONES SKIP HOIST DRIVES

FOR speedy operation, reliable service and over-all economy the Jones Skip Hoist Drive has made a name for itself in a wide variety of material handling service. These skip hoist drives are built as complete units by the Jones organization in several types with base to take any motor specified by the purchaser. They are equipped for all the modern protective devices such as cam or nut type limit switches, solenoid or disc type brakes and slack cable switches. The drives are single, double, or triple reduction Jones Herringbone Speed Reducers, built to stand up under the many years of pounding that a skip hoist drive has to take. The shafts are supported in roller bearings, with rolling action, rack generated gear and pinion teeth to insure easiest possible starting with low starting-peak loads. All reducer bearings and gears are automatic oil-bath lubricated.

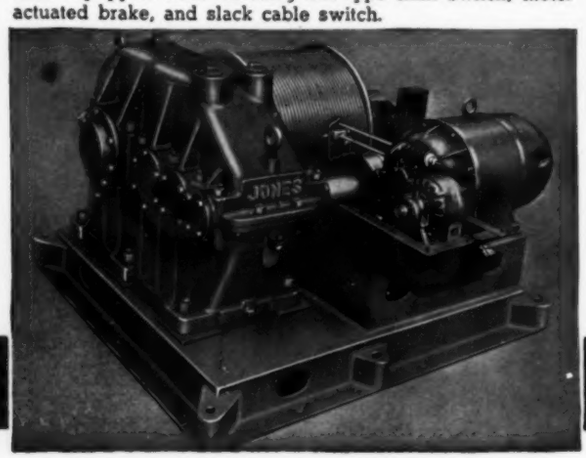
The Jones organization has an extensive file of information on skip hoist drive problems and will be pleased to work with you on any problems involving such applications.

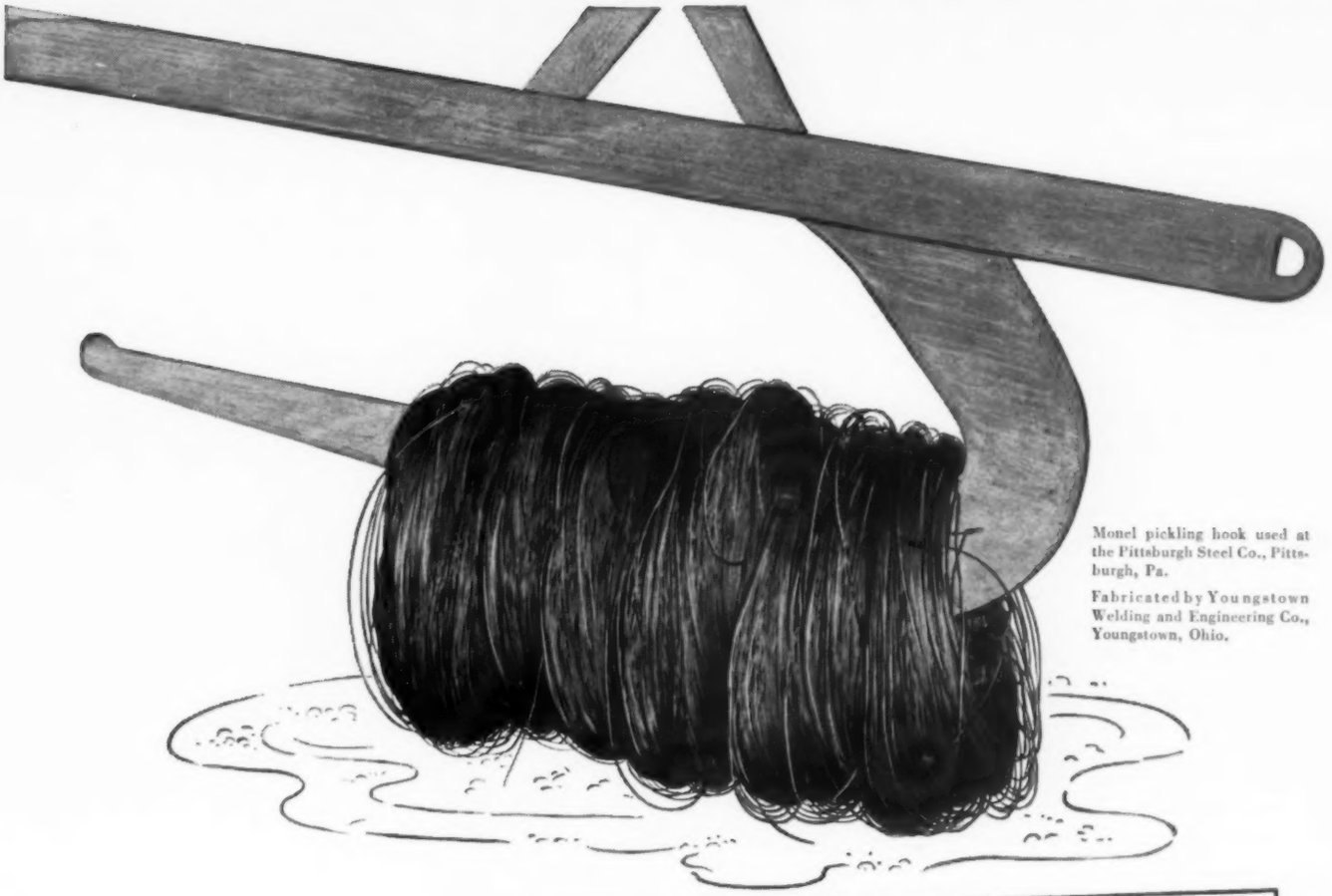
W. A. JONES FOUNDRY & MACHINE CO.
4431 Roosevelt Road, Chicago 24, Illinois

Jones
HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS
CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES
ANTI—FRICTION PILLOW BLOCKS • PULLEYS
FRICTION CLUTCHES • TRANSMISSION APPLIANCES



• The view above shows a typical Jones Skip Hoist Drive installation while the view below shows one of the Jones units equipped with traveling nut type limit switch, motor actuated brake, and slack cable switch.





Monel pickling hook used at the Pittsburgh Steel Co., Pittsburgh, Pa.

Fabricated by Youngstown Welding and Engineering Co., Youngstown, Ohio.

6 times longer life since switching to "Monel" Pickling Hooks!

Longer life is an old story to users of Monel* pickling equipment, **(over 40 years old in fact.)**

Pittsburgh Steel Company, too, found that out when they installed Monel pickling hooks to handle coils of steel wire.

Before turning to Monel, hooks of other materials had been tried. *Sulfuric acid and wire-coating chemicals ruined all of them within seven months!*

The Monel hooks, however, ended that problem. So far, they have outlasted the best of the others by six times, and are still in service after 3½ years.

Today, at Pittsburgh Steel, 14 Monel hooks are in operation, each handling payloads up to 2400 pounds.

"PICK" MONEL *for all types of pickling equipment. It can be fabricated to your needs out of economical, standard mill forms. For more information on Monel and Monel fabricators, write our Ray Reddell.* *Reg. U. S. Pat. Off.

DESIGNERS and MANUFACTURERS! Sand castings and precision castings of Monel, Nickel, Inconel and other Nickel alloys are available from Inco's own foundry.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall St., New York 5, N. Y.

EMBLEM OF SERVICE

INCO

TRADE MARK

"MONEL*" Pickling Equipment means *Extra* CAPACITY . . . *Extra* LIFE . . . *Extra* SAFETY

the Dacar Chemical Products Co. This product is an activated fuel oil treatment which readily attacks, both oil sludges and water condensation.

Use of this material has resulted in cleaner tanks and lines; less carbon deposits in preheaters and on burner tips. Overall results show less maintenance and greater efficiency in the operations of related fuel oil burning equipment.

For effective results this product is applied direct to the storage tanks in proportionate dosages per 1000 gallons of fuel oil. The material penetrates the entire body of oil within a few hours. Users report favorably, "Savings aggregating well above the cost of the material."

SMOKE DENSITY INDICATOR AIDS SMOKE ABATEMENT

▲ A new smoke density indicator and control has been announced by General Electric's control divisions. Designed specially to indicate industrial smoke density levels and thus facilitate compliance with smoke abatement ordinances, the equipment can also be used to control over-the-fire heated air to the fire-box to reduce excessive smoke and thereby improve fuel consumption and boiler efficiency.

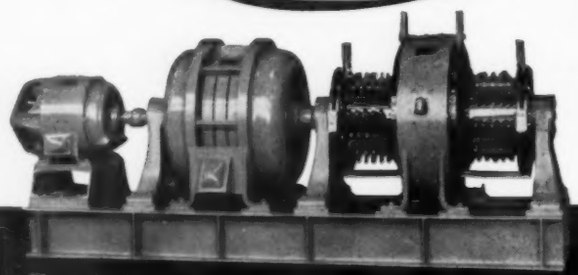
Besides reducing smoke, the unit gives improved fuel consumption and boiler efficiency.

Available immediately, the new equipment consists of a light source, a phototube holder, and an enclosure containing the required control and incorporating an indicator calibrated in Ringlemann units, all in one packaged unit. If desired a recorder, either of the continuous strip chart type or the circular "step" type, can be furnished. The equipment is sturdily constructed and dust-tight throughout. The watertight phototube holder is easily mounted on ductwork or on a stack, indoors or outdoors. The complete equipment has only a few interconnecting wires and is easy to install and maintain.

In operation, a magnetic relay is set to operate when smoke density reaches some predetermined level, such as 35 per cent, at which time a blower forces over-the-fire heated air to the firebox until the smoke density drops to approximately 15 per cent. Should the smoke density again rise, the relay is immediately energized. Each time the relay operates an alarm is sounded to warn the boiler operator to adjust the drafts in order to insure more complete fuel combustion.

Used in conjunction with this equipment, a chart type recorder provides a continuous record of smoke density. It can also be used as a measure of general operating efficiency as well as a proof of smoke ordinance compliance.

Motor Generators
by COLUMBIA



For
Electroplating — Anodizing
Electrocleaning — Electropolishing
There's a Columbia M-G Set available for your needs, whether you have a small plating bath or a large continuous strip plating line. Capacities up to 20,000 Amperes; 6 Volts and up. Dependable, performance proved, for many years. Your inquiries solicited.

Write today for Catalog IS-700
COLUMBIA ELECTRIC MFG. CO.
4543 HAMILTON AVENUE CLEVELAND 14, OHIO

BROWNING
MILL TYPE CRANES have
Plenty of Strength WHERE
STRENGTH IS NEEDED!

Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane *perfectly* to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.

"Built as you yourself would build them"

Write for our Bulletin "S".

VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes.

. . . new handy selector for pump packings

If you're using reciprocating or centrifugal pumps . . .

If your packing seals against fresh or salt, hot or cold water, steam, oil, brine, ammonia or other fluids and chemicals . . .

If you want to know the correct packing for each application . . .

If you're interested in using fewer styles of packing to do the job . . .

. . . Then you'll want this new J-M Packing Selector to keep on hand.

This handy new packing selector gives you brief, specific data on ten popular styles of Johns-Manville Packings that serve over 90% of all pump packing applications . . . shows you where to use each style for greatest efficiency and economy of service.

Here's the quick, easy way to check on your pump packing efficiency . . . to find out about lower packing costs . . . to get higher efficiency and longer life from your packings. Use the coupon, or write for your copy today to Johns-Manville, Box 290, New York 16, N.Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

PACKINGS & GASKETS

Johns-Manville
Box 290, New York 16, N. Y.

Please send me your packing selector for reciprocating and centrifugal pumps (PK-39A).

Name_____

Firm_____

Address_____

City_____ State_____

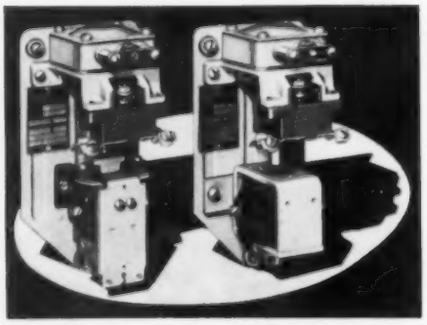
15-4

D-C PNEUMATIC TIMER GIVES ACCURATE TIMING

▲ A new d-c pneumatic timer has been announced by the Square D Co. The timer is similar in construction to the company's popular a-c design, and includes the same proven advantages.

Outstanding features of the device are: (1) Accurate timing, less than 10 per cent variation, plus or minus, from the mean timing period. Unaffected by normal changes in voltage and ambient temperature. (2) Wide range, timing period adjustable from 0.2 seconds to 3 minutes. (3) Easy timing adjustment, quick finger-tip setting of knurled knob or micrometer dial. (4) Snap action contacts, normally open and normally closed in self-contained, arc-resistant melamine case, rated for a-c or d-c control circuits. (5) Electrical interlocks, operated by the magnet which actuates the timing mechanism, frequently eliminates need for additional switching relays.

Similar in construction to the a-c design, this new timer has proven advantages.



FEI ANNOUNCES NEW FURNACE SETTING

▲ A new setting for galvanizing furnaces which is reported to increase production as much as 50 per cent has been developed by Furnace Engineers, Inc.

The new setting also cuts production costs by increasing pot life and reducing fuel consumption. In one installation for galvanizing pipe, where normal pot life expectation was 20,000 tons, the new setting produced 70,000 tons before the pot required replacement. No repairs to the pot whatever were necessary during this production.

Because the new setting allows for minimum of fuel use during idling periods and provides for quick starting-up, overall fuel costs are substantially lowered.

DISCHARGE CHECK VALVE PREVENTS PUMP FOULING

▲ A discharge check valve has been designed by J. A. Zurn Manufacturing Co. that protects against contamination of liquids, fouling of pumps and equipment, reduces maintenance costs and prevents production difficulties in industrial plants wherever back surge is a problem. These units serve an important function in discharge lines, carrying steam, sludge, waste water, and many other waste liquids in gravity flow installations.

To minimize fouling of the valve, these units have a swing check flap suspended from a full floating pin fulcrum to insure positive full surface contact between ground face of flap and flap seat. The knob in the center of the top surface of the swing check flap contacts the valve body roof at only one point when the swing check flap is wide open. This assures

HYDRAULIC ENEMY No.1 UNCLEAN OIL

ARREST HIM WITH

MARVEL SYNCLINAL FILTERS

always on the job protecting hydraulic production equipment.

2½ TIMES MORE FILTERING AREA THAN EQUIVALENT SIZE CIRCULAR TYPE FILTERS

This means maximum filtration in less space. Standard 100 mesh (.0050 opening) insert — others range from course 30 mesh to fine 200 mesh inserts. Adaptable to meet any filtering problem.

SUMP TYPE IN 6 CAPACITY SIZES — 4 PIPE SIZES

—50, 30, 20, 10, 8, or 5 GAL. per minute. Increased capacity easily obtainable with manifold installations.

Write for Catalog No. 103 containing complete engineering data.

MARVEL ENGINEERING COMPANY

625 W. Jackson Blvd., Dept. 59, Chicago, Illinois

–this is worth buying!

WHEN you order Oakite Composition No. 97 for machine precleaning of steel or Oakite Composition No. 24 for tank cleaning or Oakite Pickle Control No. 3 for hot sulphuric-acid pickling — you buy a lot more than drums of chemicals.

What you actually buy is *Oakite service*, which combines the knowledge gained in 40 years of chemical research with the practical engineering experience of more than 180 Oakite Technical Service Representatives working for tens of thousands of customers per year.

To discover the great value of *Oakite service*, phone the Oakite Technical Service Representative in your city or write to Oakite Products, Inc., 19 Thames St., New York 6, N. Y.

OAKITE 1909 1949 40th ANNIVERSARY YEAR

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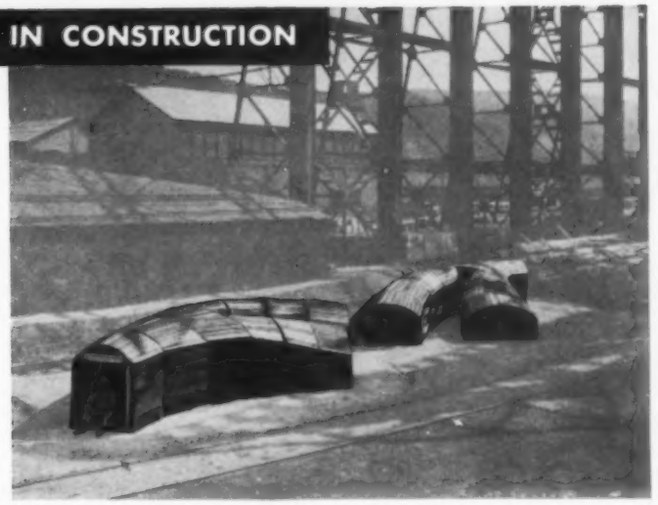
INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

COSTS CUT, TIME SAVED

in Open-Hearth Flues built with adaptable *LUMNITE Refractory Concrete



CONSTRUCTION: A 50% saving in cost was realized. In addition, construction time was considerably reduced by using LUMNITE Refractory Concrete on this job in 1943. This complex system of curved walls and tapered arches was cast in place without trimming, cutting or fitting. The Refractory Concrete was made with LUMNITE calcium-aluminate cement and aggregate prepared on the site from salvaged fireclay brick. The cost advantage was reaffirmed later when two other sets of open-hearth flues connecting checkers and stacks were rebuilt with Refractory Concrete at the same steel mill.

SERVICE: Observe, in picture (lower right, above), the excellent condition of these same flues after five years' service. Note the sharp angles and smooth curves. There are no ragged walls, no flattened arches—no debris on the floor. With its monolithic, one-piece construction, there are no small units to work loose and weaken the structure. Excessive heat does not cause the Refractory Concrete to deteriorate. Maintenance expenses stay low. Installations are ready for service within 24 hours or less after placing.

• • •

FOR BOOKLET describing these open-hearth flues and a manual on Refractory Concrete, write Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N.Y.

"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

18-L-12

LUMNITE® FOR **REFRACTORY CONCRETE**

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—ABC Network*

The valve has a swing check flap to insure positive full surface contact.

free operation of the swing check flap by preventing it from touching the sides of the valve body. Location of swing check flap in relation to the interior of valve body provides ample protection against the possibility of sediment blocking the valve. Swing check flap suspended from cover can be replaced and removed easily.

CAR SHAKER FITS ALL GONDOLA CAR SIZES

▲ A new car shaker for emptying coal, cinders, ore, slag, coke, sand and gravel and other granular materials quickly and safely from drop-bottom gondola cars has been announced by Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Weighing approximately five tons, the new car shaker is designed to fit all sizes of gondola cars manufactured in the United States. It has an all-welded 11 x 5 x 4 ft 4 in. steel body which is lowered to rest on the car body flanges by a hoist or crane.

Vibratory motion is transmitted to the car through an eccentric shaft mounted within the shaker body on heavy-duty bearings. The unit is driven by a totally-enclosed, high-torque, rubber-mounted motor located inside the shaker body for full protection. A completely enclosed Texrope drive with deep groove sheaves is used for power transmission.

The new shaker incorporates such features as a stress-relieved body, and a completely new design mechanism with a minimum of working parts. It is expected to find a ready market wherever a saving of time and labor is desired as well as improved safety conditions in the continuous unloading of drop-bottom gondola cars.

OXYGEN METER NOW IN FULL PRODUCTION

▲ After several months of field testing, the "Magno-Therm" oxygen meter is now in production according to the announcement just released by Hays Corp.

The oxygen meter is unique among oxygen meters in that it operates on an entirely new principle based on the paramagnetic property of oxygen, from which it gets its name. It continuously analyzes, indicates and records the percentage of oxygen in boiler flue gases and in industrial gases. Gas to be analyzed is passed through a cell block in which there are two cells containing heated resistors. The sample gas diffuses into

Introducing the New
"Luminum-Line"
Plate and Pipe Marker
IT'S
ALUMINUM
50% Lighter than
Steel Holders
CARH
7 3 5 2 1 B
This new "Safety" steel stamp holder of cast aluminum is "easy on the operator" . . . gives long-life, rugged and dependable service . . . for all heavy-duty plate and pipe marking.
Write today for data and proposal!
M.E. CUNNINGHAM CO.
SAFETY STEEL STAMPS
105 East Carson Street • Pittsburgh 19, Pa.

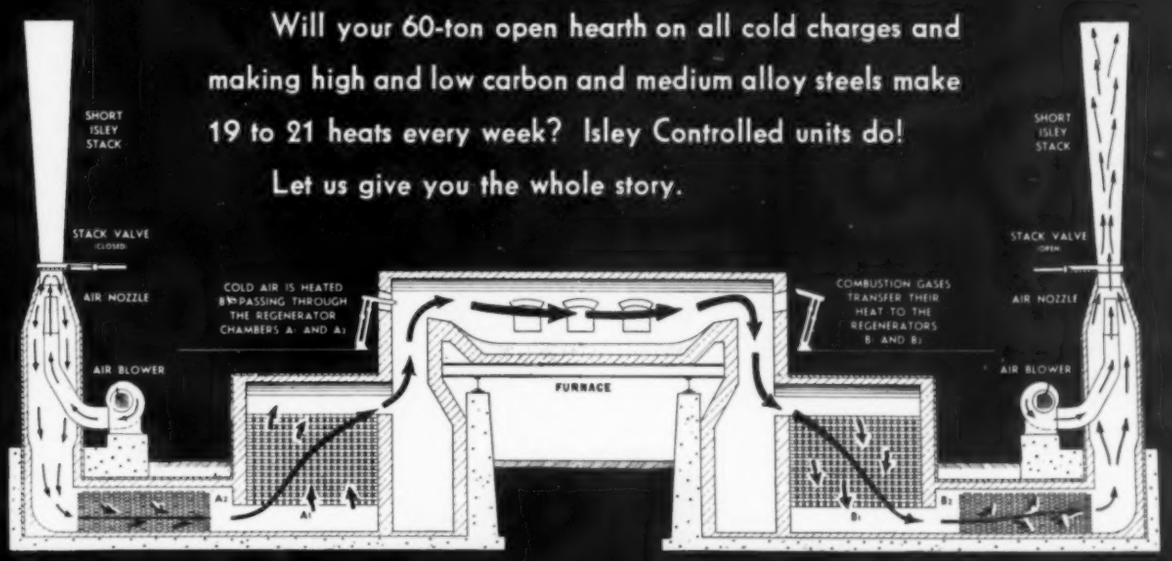
SPEED UP YOUR FURNACES

with the ISLEY SYSTEM of FURNACE CONTROL

You can get more production from your regenerative furnaces. Equip them with the Isley Control System. It gives up to 50% more regenerative capacity . . . gets more fuel burned per hour . . . produces faster heats with higher furnace temperatures.

Will your 60-ton open hearth on all cold charges and making high and low carbon and medium alloy steels make 19 to 21 heats every week? Isley Controlled units do!

Let us give you the whole story.

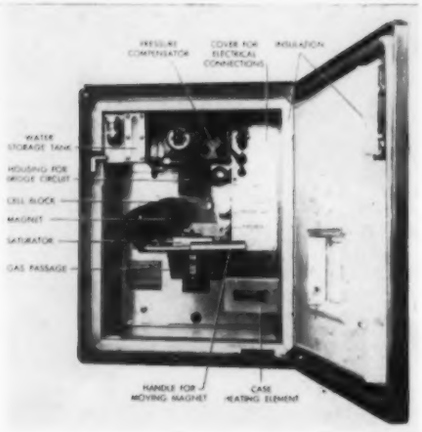


MORGAN CONSTRUCTION COMPANY

WORCESTER, MASSACHUSETTS

CCC-11

PITTSBURGH, PA., 2815 Koppers Building . . . English Representative, International Construction Company, 55 Kingsway, London W. C. 2, England



The new meter operates on a principle based on the paramagnetic property of oxygen.

both cells. A strong magnetic field from a permanent magnet is directed across one resistor in the measuring cell. The oxygen bearing gas is attracted into the magnetic field (oxygen is paramagnetic) and becomes heated by the hot resistor. The oxygen loses its magnetism as it becomes heated and is forced out of the magnetic field by the cooler more magnetic oxygen. The cooling effect on the heated resistor is proportional to the magnetism of the gas entering the cell. This changes its electrical resistance and increases the flow of current through it. The change in flow of current is compared with the flow of current in the comparison cell resistor (without a magnetic field) and the difference in resistance is measured by the Hays Acratron Electronic Type Recorder, calibrated to read in per cent oxygen.

The measure is compensated for ambient temperature, barometric pressure and variable moisture content of the gas sample.

AIR IMPACT WRENCH FOR HEAVY EQUIPMENT

▲ Heavy industries will find a valuable addition to their production and maintenance equipment in the new large-capacity air impact wrench developed by the Ingersoll-Rand Co. This wrench helps to get heavy equipment back into service quickly by reducing time required for repairs. In addition it eases the manual load on the workmen and frees them for other jobs in a shorter time.

Because it shortens repair time on essential equipment, the impact wrench often pays for itself in one maintenance operation. In the scheduled tear down of a rolling mill, where down time was charged at $10 per minute, the impact wrench cut the time on a four hour hand job to one and one-half hours, saving $1500 down time charges. Here the impact wrench paid for itself in only 42 minutes use.

The size 577 impact wrench is designed to handle large studs, bolts, nuts, and cap screws from 1¼ in. up to 2 in. thread size.

The wrench operates on the rotary impact principle, by which motor torque is converted into 1000 powerful rotary impact blows per minute. This principle, which has proven its dependability in production and maintenance work, makes the machine ideal for running or removing large nuts. It is especially valuable for removing rusted or frozen nuts, and for drawing nuts and cap screws tight.

The new wrench furnishes plenty of power for heavy work although it weighs only 72 lb (less socket) due

CLEAN PIPES
mean greater efficiency

▶Keeping your pipes in condition to deliver maximum efficiency of performance means keeping them *clean* — and we can do that job for you easier and cheaper than you can do it for yourself. We have the specialized equipment, the experience and the trained personnel to clean, rehabilitate and maintain all types of pipes and piping systems.

Many leading industrial organizations use our services exclusively. May we tell you in detail about the benefits they receive—and that are available to you. Just write or call.

EASTERN PIPE MAINTENANCE COMPANY
716 CLARK BUILDING
PITTSBURGH 22, PA. GRant 1002

Here's What Happens to Your
NON-FERROUS CASTING ORDER AT FALCON

Falcon Bronze is a company owned by the casting specialists who work there. When your non-ferrous casting order arrives — by phone, wire or mail — it comes to the immediate attention of these working-owners. Without departmental routine or other impersonal delay, patterns are promptly readied and production started. Close, expert supervision through each step of production eliminates possibility of your order becoming side-tracked, assures highest quality standards of casting. A final, close check to make sure that every requirement has been met, that flawless casting has been accomplished — and another fast, satisfactory delivery is on its way.

When you need quality castings in a hurry, try the personal attention of Falcon specialists.

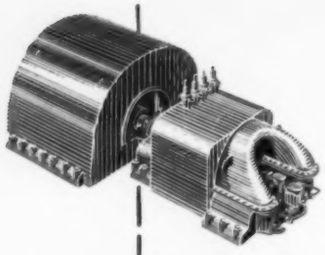
Telephone Collect – 3-4186
FALCON BRONZE CO.
YOUNGSTOWN 3, OHIO
Established 1890 • Incorporated 1895

Illustrated is an installation of Falcon-produced Kinney Refractory-Lined Tuyere Cooler, U. S. Pat. App. Serial 530153, and Holzworth "Split Nose" Tuyere, U. S. Pat. 1,789,870.

Unfrightened by dire predictions, leaders of American business always have planned with confidence in the future . . . and, in the long run, their faith has paid off. Such courageous leadership helps to *create* good business.

Good business means jobs for those who want to work. It's the best defense against the termites who are working to undermine the individual liberties Americans enjoy. 6593

SKF INDUSTRIES, INC. PHILADELPHIA
BALL and ROLLER BEARINGS



New life expectancy for impeller blades ..with Super-Clean Air!

ABRASIVE dust and dirt entering a high-speed rotary blower are sure death to steel impeller blades. When these blades hit this grit-loaded air, it's like trying to cut through a sandstorm. Rapid wear and erosion result, and you have a replacement problem on your hands.

But there's a sure-fire answer to this problem: AAF Multi-Duty Air Filters. Installed at the blower intake, AAF Multi-Duty filters out abrasive particles—preventing this killing dust and dirt from reaching the rotary blower.

The AAF Multi-Duty is an automatic, self-cleaning air filter. Overlapping panel construction combines self-cleaning and high efficiency air cleaning as integral functions of the operating cycle. Uniformly constant air supply is assured as operating resistance remains fixed when once established for a given dust concentration.

Increase the life expectancy of your impeller blades with AAF Multi-Duty Air Filters—you'll find the cost is only a fraction of the savings. Write for complete information or call your nearest AAF representative.

American Air Filter Company, Inc.
302 Central Ave., Louisville 8, Ky.
In Canada:
Darling Bros. Ltd., Montreal, P. Q.

AAF
AIR FILTERS
AND DUST CONTROL EQUIPMENT

to the extensive use of magnesium in the housings. Durability and ease of handling are other important features which facilitate its use.

HYDRAULIC DYNAMOMETER FOR REPAIR SHOPS

▲ Hydraulic dynamometers, designed, built, and used by the Wagner Electric Corp. have now been made available to electric motor repair shops and other establishments where accurate load-testing of motors is an important operation. Designed especially for this purpose, the dynamometer has proved itself a practical, workable piece of shop equipment, and one that is surprisingly simple to use.

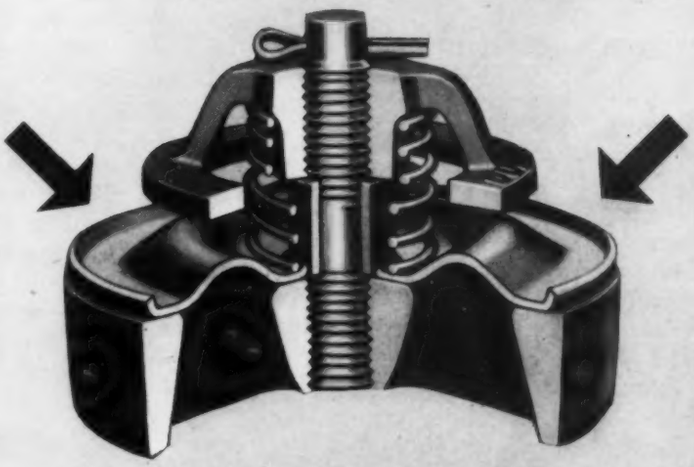
Tests that can be made with the dynamometer include idle, pull-in, pull-up, full-load and locked. The locked test can be made without having to shut off the motor to insert a locking pin or similar device. All tests require very little effort on the part of the operator; the dynamometer is foot controlled, and both the operator's hands are free. Exact foot-pounds of torque can be read directly from the gage furnished with the dynamometer.

Hydraulic dynamometer assembly No. SA-483 is of 30 ft-lb capacity, and has adapters for ½, ⅝, ¾ and 1 in. motor shafts. The dynamometer comes fully assembled on a steel bench top, approximately 36 in. square, which may be mounted on

Designed for shop work, this new hydraulic dynamometer has proved to be practical.

DURABLA

Valve Member Utilizes Arch Construction For Strength But Can Flex To Adjust To Any Slight Variations In Plane Of Valve Seats.



Valve Member Is Free To Move Around The Guard-Stem Or To Assume Any Angle And Maintains A Seal Which Is Self-Grinding At All Times

PUMP VALVE SERVICE

The patented arch construction Durabla Valve Member* retains sufficient flexibility, despite its great strength, so that the valve-to-seat contact maintains a constant pressure-proof seal. The Valve Seat is rigid, the Valve Member is freely mounted. Hence the free member accommodates itself to wear of the valve parts which may occur in severe service.

Since the Valve Member is freely mounted, a unique feature of Durabla engineering, it can turn about the Guard-Stem and a self-grinding pressure-proof seal is always maintained. Lower maintenance costs; Infrequent need for inspection; Minimum lost time for repairs are all achieved through the use of Durabla "The Valve That Grinds Itself."

Address DURABLA Engineering Department for Information and Bulletin No. 954

* Patent Numbers 2090486, 2117504

DURABLA MANUFACTURING COMPANY
114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO

standard steel bench legs or on existing benches in test or assembly lines. Foot-control cylinder for operating dynamometer can be placed in the most convenient location.

Other dynamometers are available as follows: SA-484, 30 to 300 ft-lb capacity, with adapters for 1⅛, 1¼, 1⅜, 1⅞, 2⅛, 2⅜, 2⅝ and 2⅞ in. motor shafts; and SA-485, which is a combination of the 30 ft-lb and the 30 to 300 ft-lb machines.

MODIFY LINE OF LIGHTING FIXTURES

▲ Thompson Electric Co. has announced the modification of its complete line of disconnecting and lowering hangers to incorporate a heat-treated aluminum alloy casting for the positioning stem and a redesigned, stronger guide tube. The new aluminum alloy stem, a permanent mold casting, provides greater strength at less weight than the formerly used malleable iron casting and is more resistant to corrosive atmospheres and extreme weathering.

This new positioning stem also features a multiple rig design which (1) allows accurate forming of the diameter to within 0.001 in., (2) decreases the metal to metal contact, and (3) reduces the clearance required between the stem and guide.

A complete hanger assembly consists of two members, upper and lower.

The slotted guide tube has been reinforced throughout and provided with a larger bearing surface for greater strength and to assure safe support of heavy lighting fixtures in all types of installations, including outdoor floodlights subject to high wind pressures and indoor lights subject to constant vibrations or hard shocks.

A remotely-controlled, latching type, overhead, disconnecting switch combined with a fixture lowering and raising device, the hanger provides for low-cost, safe maintenance by lowering overhead lights to floor level for cleaning, lamp replacement, or repair. A complete hanger assembly consists of two members, upper and lower. The fixed upper member contains a pulley wheel for the operating chain or cable, the slotted guide tube, and a pair of cup-type contacts to which the feed wires are attached. The lower member, which supports lighting fixture, contains the positioning stem, the latching mechanism, and a pair of ball-face contacts which complete the circuit when the fixture is repositioned.

USE THE
ENGINEERING MART
Pages 189 and 190

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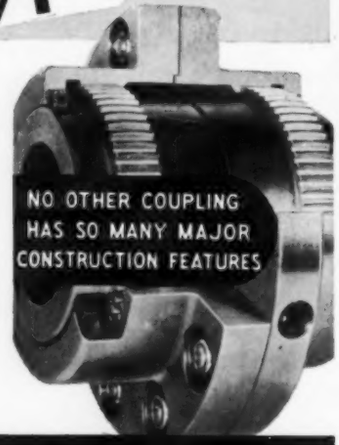
Improved
Gear Type

USED BY AMERICA'S LEADING MACHINE BUILDERS

Users recognize the WALDRON Coupling as the most advanced design of the Gear Type. Compare it with ordinary types from a standpoint of shaft size, horsepower, speed and service. For design and construction details, ratings, service factors, etc.—write for descriptive catalog.



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Sales Representatives in Principal Cities.

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GOOD railroad siding, like that pictured above which we constructed for Sears, Roebuck & Co., pays off in the elimination of costly delays and the speeding up of traffic. Proper construction and maintenance of railroad siding is an insurance invaluable to you.

We are staffed and equipped to survey your track layout, recommend and execute a complete program of repair, rehabilitating and future maintenance. We'll be glad to consult with you at your convenience.

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On the job LONGER *with* P-G...

Continuous

TROUBLE FREE SERVICE

P-G *Steel Grid Resistors* built of steel and mica, coupled with exclusive features of design, make P-G Resistors capable of constant "Trouble Free" service. Specify P-G for maximum production with minimum maintenance.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

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God bless you, mister

. . . thousands of Cancer patients are grateful to you!

Cancer's annual toll of 200,000 lives is grim proof of the need for your continued generosity. The money you contribute to the American Cancer Society helps pay for the development of methods of treatment which are now saving about one-quarter of the people who are stricken with Cancer . . . people who might otherwise have died. Your money supports the work of more than a thousand specialists who are fighting to find the cause and cure of Cancer. And it finances a vast education program that trains professional groups, tells the public how to recognize Cancer and what to do about it.

Your life—the life of everyone you know—is at stake. Your investment can mean health and happiness to millions. Thank you . . . and God Bless You, Mister.

just mail it to

CANCER

Just write "CANCER" on the envelope containing your contribution. It will be delivered to the American Cancer Society office in your state.

STEEL WAREHOUSE CUTS HANDLING COSTS

75% for heavy stock
30% for light stock

WITH

BAKER CRANE TRUCK

A steel supply company faced the handling problem of unloading sheet stock, bar stock and pipe from box cars, storing it in special racks, and loading it onto highway trucks for delivery to its customers. Even with a lift truck, much manual handling was required.

The problem was solved with a Baker 2-ton Crane Truck, which quickly and easily unloads material from box cars to a point where it can be handled by overhead crane. The Baker Truck also facilitates placing material in racks (as shown) and loading highway trucks. Its use has effected savings of 30% handling light stock, and 75% for heavy stock.

A Baker Material Handling Engineer can show you how similar savings are possible in your plant.

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker-Raulang Co.
1229 WEST 80TH STREET • CLEVELAND, OHIO
In Canada: Railway & Power Engineering Corp., Ltd.

Baker INDUSTRIAL TRUCKS

Speer carbon brushes

REFLECT

A Vast Accumulation of Performance Data

A half-century of experience analyzing local conditions influencing carbon brush performance, and the development of brush grades to eliminate specific difficulties, account for a vast accumulation of data at Speer Carbon Company laboratories.

Here, case histories and modern experimental and testing facilities are available for the analysis of your problems, whether they pertain to electric motor brush design, or maintenance. Write for the brush data sheet, shown below, for use in submitting your particular problem.

BRUSH DATA SHEET

GENERAL

Company ..... Address .....
Location of Machine and Identifying No. ..... Brush Blue Print No. .....
Recommendation ..... Submitted by ..... Date .....

DATA ON MACHINE

Motor, Generator or Rotary ..... Built by .....
Used for what service .....
Type ..... Form ..... Serial ..... Kv-a. or H. P. .....
AC or DC ..... Voltage ..... Cycles ..... Phase .....
R.P.M. ..... No. of main poles ..... Do main poles have compensating windings? .....
No. of interpoles ..... Are they series, shunt, compound or separately excited? .....
Rated load in amps ..... Average load in amps .....
Maximum load in amps ..... Duration of maximum load .....
Does machine run in one direction only? .....
Do DC Brushes run radial, leading or trailing? .....
Do AC Brushes run radial, leading or trailing? .....

Radial Leading Trailing

Commutator { Diameter ..... No. of segments ..... Flush or undercut mica ..... } Rings { Diameter ..... Number ..... Material ..... }
Number of brushes per set, AC ..... DC ..... Spring pressure DC .....
Grade of brush now in use, AC ..... DC ..... Spring pressure AC .....
Are present brushes satisfactory? ..... If not give details .....
.....
.....
.....
Do brushes spark, glow, squeal or squeak? .....
Do brush faces show high polish, copper spots, etc.? .....
Is commutator or rings burned, roughened, worn or discolored? .....
Is there evidence of high mica? .....
Are there flat spots? .....
What grade or grades of brushes have worked successfully? .....
Remarks: .....

Speer
CARBON COMPANY
ST. MARYS, PENNA.

brushes · contacts · welding electrodes · graphite anodes · rheostat discs · packing rings · carbon parts

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THE ENGINEERING MART

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Complete Material Handling Systems
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Electric Industrial Trucks
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Book Reviews

▲ "Steel Plates and Their Fabrication," a reference book for engineers, and designers, who work with steel plates and with structures of which steel plates are a part, has been published by Lukens Steel Co. The 408-page book, bound in red cloth, was edited by Lionel S. Marks, Gordon McKay professor of mechanical engineering, emiritus of Harvard University.

"Steel Plates and Their Fabrication" contains extensive data of value for ready reference in selecting steel plates best suited to particular projects. The book contains information also on the analyses of physical properties of carbon and low alloy steels with charts and tables showing their behavior under sustained and repeated loadings and their resistance to abrasion, corrosion and temperatures.

The book also contains much factual material on nickel, stainless, inconel and monel-clad steels, their physical and mechanical properties, and plate and head sizes.

"Steel Plates and Their Fabrication" includes historical data and information on open hearth steelmaking, welding, the effect of plate widths on fabrication costs, strength of flat plates and shells; forming flanging, pressing, flame-cutting; fabricated assemblies, and pressure vessels and tanks. A section of more than 100 pages of general engineering information, including mathematical tables, conversion tables and other material of frequent reference, also is included.

The book is profusely illustrated with approximately 375 charts, graphs, isometric or other explanatory drawings, and photographs of steelmaking and fabricating operations as well as of steel plate products and machinery.

Engineers and designers desiring a copy of the handbook should make their request on their company letterhead to Lukens Steel Co., 118 Highway Building, Coatesville, Pa.

▲ Publication of a "Light Gage Steel Design Manual" for the use of architects, designers and structural engineers was announced by the Committee on Building Codes of American Iron and Steel Institute.

The manual supplements the official "Specification for the Design of Light Gage Steel Structural Members," published by the Institute in 1946. It includes design charts and the structural properties of structural members cold-formed from light gage steel.

The use of light gage structural sections, made by cold-forming sheet or strip steel is increasing in popularity with designers. High-speed manufacturing methods have been developed, adding to the economy of production. The fire safety gained by the use of an incombustible type of construction also has strong appeal. Light gage sections frequently are specified for various lightload structural purposes, in which members lighter than the conventional hot-rolled shapes can be used to advantage.

The manual includes tables of structural properties and other design information for the following basic sections:

Two channels with stiffened flanges, back-to-back.

Two channels with unstiffened flanges, back-to-back.

Two equal leg unstiffened angles, back-to-back.

Single channels and zees with stiffened flanges.

Single channels and zees with unstiffened flanges.

Equal leg unstiffened angels.

Properties of these sections are tabulated for steel sheet or strip of thicknesses from 0.135 in. to 0.048 in., with nominal gage numbers from 10 to 18.

Design charts are given for light gage structural members in bending and under compression; effective design widths for load determination and deflection determination. Examples of practical design problems illustrate the use of the tables and charts.

Manuals may be obtained from the American Iron and Steel Institute, 350 Fifth Ave., New York 1, N. Y., price $1.00.

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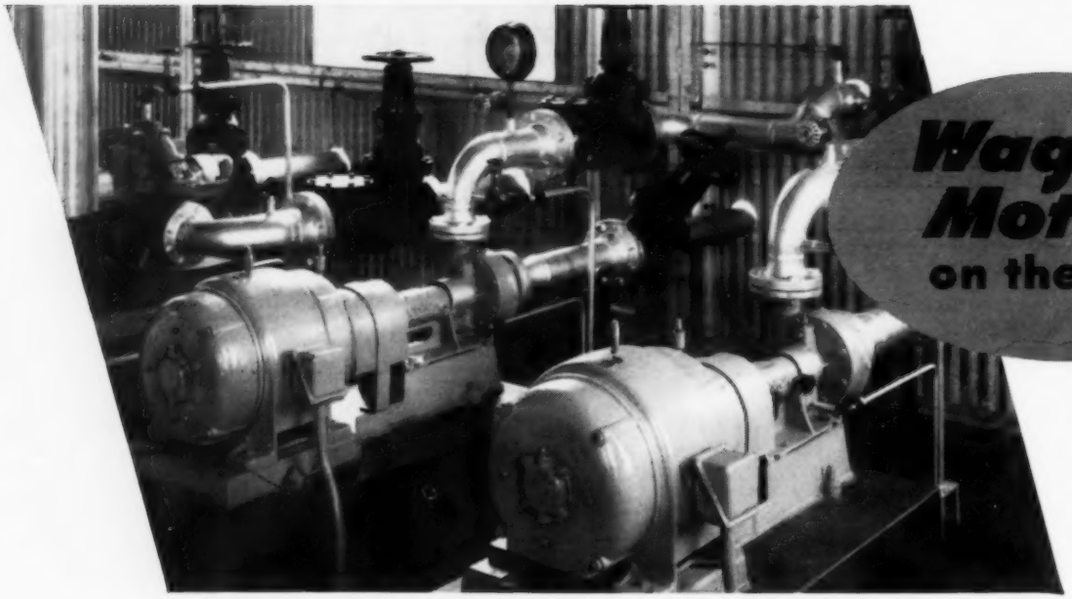

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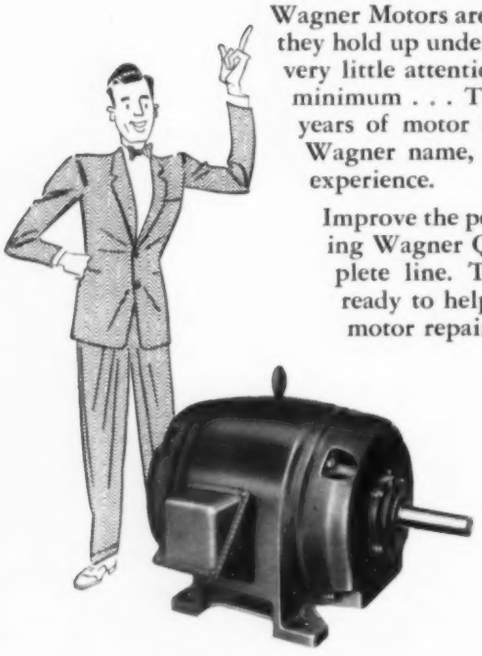

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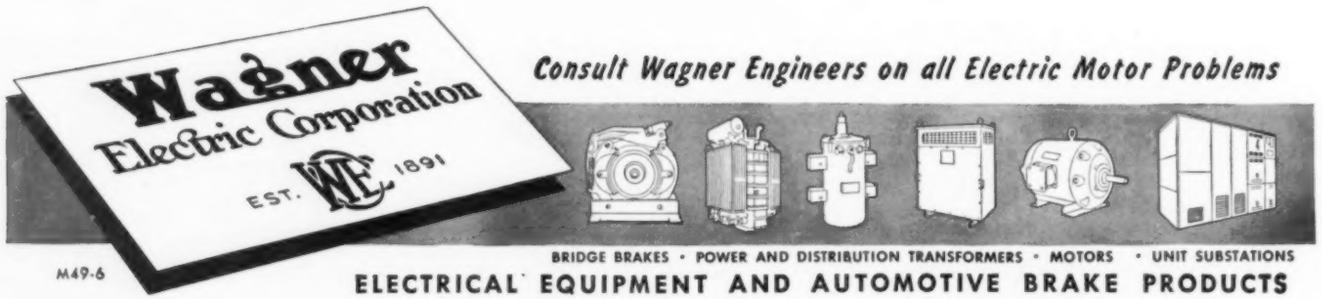

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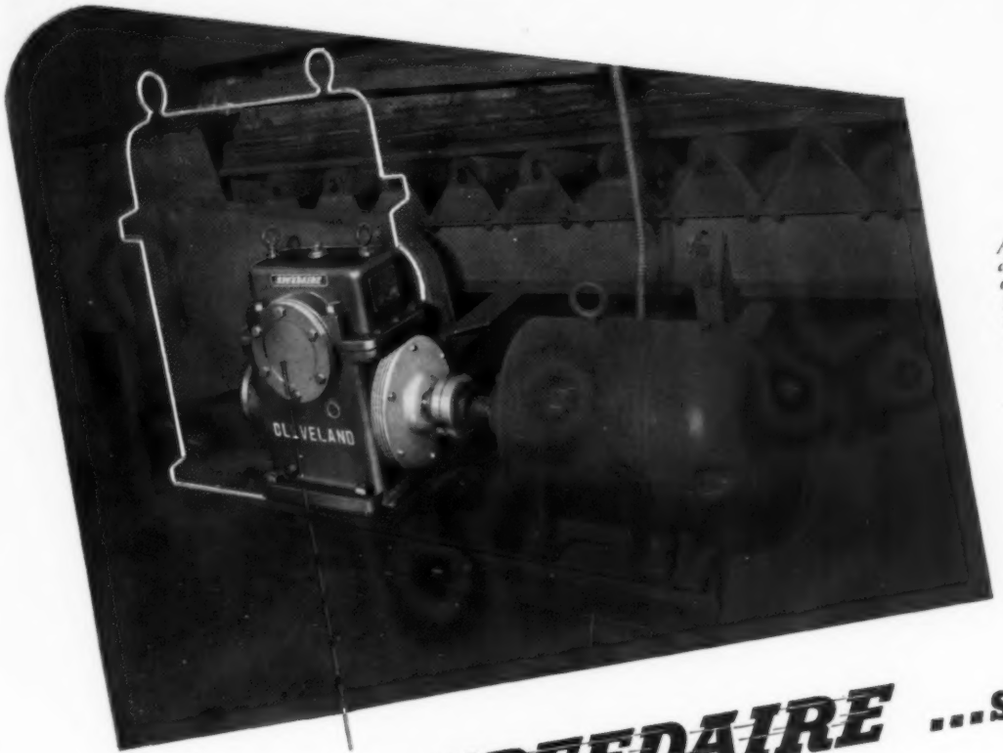

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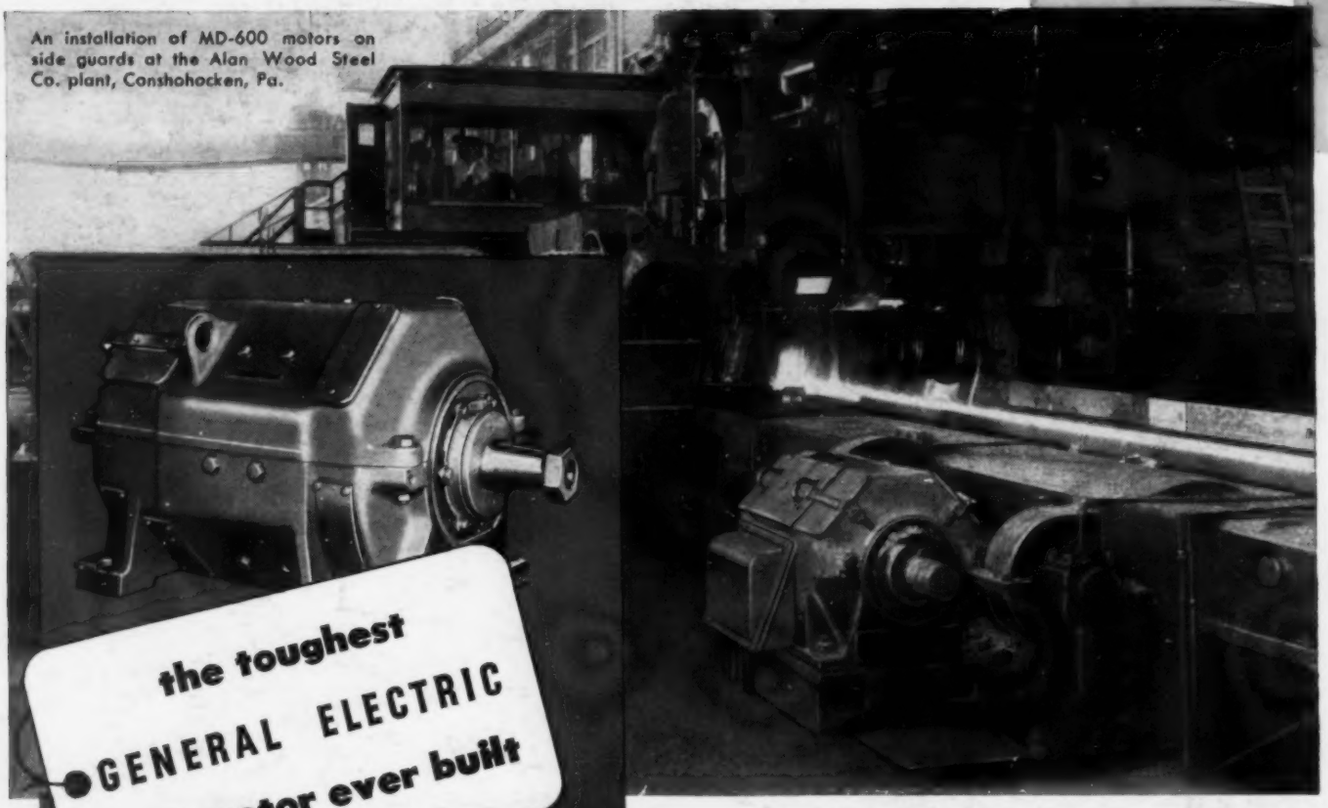

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